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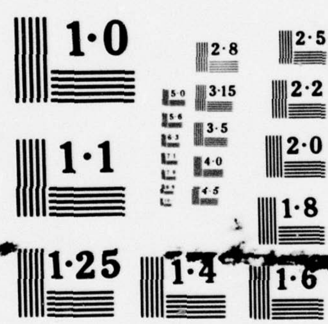
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LEVEL IV

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Discrete Address Beacon System

DABS SINGLE SENSOR PERFORMANCE TEST PLAN

Martin / Holt

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JULY 1979

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
National Aviation Facilities Experimental Center
Atlantic City, New Jersey 08405

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NOTICE

TEST PLAN

NAFEC Program Document No. 03-110 — DABS Test and Evaluation

Subprogram No. 034-241 — Experimentation and Testing Support for DABS

NAFEC Project No. 510 — System Integration Operation, Test and Evaluation (System T&E)

The Test Plan contained herein has been established as a technical and operational document, outlining the effort to be applied in the accomplishment of the NAFEC Project.

This Test Plan was prepared on the basis of the best information available to the Associate Program Manager. It is emphasized that this is a research and development effort and that changes in the plan may be dictated by experience as the work progresses. Any such changes will be accompanied by coordination and appropriate consultation with the Engineering Management Staff and other affected NAFEC elements. Other involved personnel will be advised.

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JULY 1979

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ABSTRACT

This document describes the single-sensor performance tests to be conducted by the National Aviation Facilities Experimental Center (NAFEC) upon three ~~Engineering Laboratory~~ models of the Discrete Address Beacon System (DABS) sensor. These sensors are to be installed at NAFEC and two adjacent sites: Elwood and Clementon, New Jersey.

These performance tests will primarily address the following characteristics: Surveillance Processing, Accuracy and Resolution, Data Link, Performance Monitoring and Failure Recovery, Network Management (stand-alone mode) and Communications. The results of these performance tests will be used to prepare a technical data package for DABS procurement by the Operating Services.

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EXECUTIVE SUMMARY

The Discrete Address Beacon System (DABS) has been designed as an evolutionary replacement for the Air Traffic Control Radar Beacon System (ATCRBS) to provide the enhanced surveillance and communications capability required for Air Traffic Control (ATC) in the 1980's and 1990's. Compatibility with ATCRBS has been emphasized to permit an extended and economical transition.

The requirement for the development of DABS was identified in the 1969 Department of Transportation Air Traffic Control Advisory Committee Study. The first phase of DABS development consisted of a feasibility study and validation of the DABS concept. This study was conducted by the Massachusetts Institute of Technology (MIT) Lincoln Laboratory. After successfully demonstrating the feasibility of the DABS concept, engineering requirements (ER's) were prepared by Lincoln Laboratory for the development of three single-channel DABS sensors which could operate as a network and interface with enroute and terminal ATC facilities.

Texas Instruments, Inc., (TI) was awarded a contract to fabricate the three Engineering Laboratory models of the DABS sensor. These are to be installed at the National Aviation Facilities Experimental Center (NAFEC), Clementon, and Elwood, New Jersey. After completing Factory Acceptance Tests, the sensors will be delivered to the three sites, installed, and subjected to Field Acceptance tests. All of this will be the responsibility of TI with NAFEC and other Federal Aviation Administration (FAA) personnel providing assistance. Upon completion of the Field Acceptance Tests, the Performance Tests outlined in this document will be performed on the sensors by NAFEC.

The purpose of these Performance Tests is to comprehensively evaluate the system-level performance of the DABS sensor operating in the stand-alone mode. In the stand-alone mode, assignment of sensor primary/secondary status and the management of DABS lockout for target handoff and acquisition of controlled targets is made by the associated Air Traffic Control (ATC) facility rather than by the Network Management function of the sensor. The characteristics of the sensor which will be evaluated include Surveillance, the Air-Ground Data Link, Channel Management, Network Management, Performance Monitoring and Communications. The functional performance of the DABS computers and the accuracy and resolution characteristics of each of the three sensors will also be measured. Finally, reliability and maintainability data on the three sensors will be collected and analyzed. The principal product of these performance tests will be the technical data that will be provided to Systems Research and Development Service (SRDS) for incorporation into a Technical Data Package (TDP) which will be handed off to the Operating Services by April 1980.

The above-listed characteristics will be evaluated by two major categories of tests: functional and system. These test categories will run concurrently rather than sequentially. The essential differences between these two test categories are that the functional tests emphasize static inputs and simulated flight conditions while the system tests make greater use of dynamic inputs and flight testing. These two test categories will comprise the main effort of the Performance Tests.

A third test category, Subsystem Tests, will also be included, although largely on a time-permitting basis. The Subsystem Tests will supplement the extensive hardware and software subsystem testing performed by TI during the Factory and Field Acceptance Tests and will be used to fill in any gaps in these areas which are felt to exist. Subsystem tests on the ATCRBS and DABS Processors and on portions of the Receiver will be performed and data included in the April 1980 TDP. While the remaining Subsystem Tests will only be performed on a time-available basis, they are described in this document in their entirety for the purpose of completeness.

Section 1 of this document is the Introduction and provides a general background of the DABS Development Test and Evaluation (DT&E) program. Section 2 consists of a general overview of all the major tests in the three test categories comprising this effort. Section 3 consists of a functional and physical description of the sensor, including hardware and software.

The three categories of Performance Testing (Subsystem, Functional and System) are described in sections 4.0, 5.0, and 6.0 respectively. Each test description contains an overview; a statement of objectives; a description of data collection techniques, results and analysis; and resource requirements.

Section 7.0 of the document addresses the various functions which will support the DABS Test and Evaluation effort. These include statistical analysis, software support programs, and system operation and maintenance. Value Engineering procedures which will attempt to identify areas where design simplification and cost reduction can be obtained without sacrificing required functional performance and equipment reliability are also discussed in this section.

Configuration Control of both hardware and software documention is addressed in section 8.0 of this document. Section 9 comprises a summary of other test and evaluation efforts relating to DABS. These include Automatic Traffic Advisory and Resolution Service (ATARS), Data Link Utilization Tests, DABS/ATC System testing with both enroute and terminal facilities, DABS/ATCRBS Compatibility Testing and DABS/Mode 4 Compatibility Testing. Test plans for these efforts will be covered under separate documents.

Detailed test schedules are shown in section 10.0.

1.0 INTRODUCTION

1.1 PURPOSE

The purpose of the Performance Tests of the Engineering Laboratory Models of the Discrete Address Beacon System (DABS) sensors is to obtain technical data on the hardware, software and functional performance characteristics of these sensors primarily at the system level. The results of the performance tests described in this document will be incorporated into the DABS single-sensor Technical Data Package (TDP).

1.2 BACKGROUND

The requirement for the development of DABS was identified in the 1969 Department of Transportation Air Traffic Control Advisory Committee study. This study required that (1) the present Air Traffic Control Radar Beacon System (ATCRBS) be upgraded to incorporate data link and discrete address capabilities and (2) this upgraded ATCRBS, including its data link and computational facilities, be integrated with enroute and terminal ATC facilities. The incorporation of the data link and discrete address capabilities into the upgraded ATCRBS comprises the essential features of the DABS sensor. The committee also recommended the development of a ground-based collision avoidance system which would, on the basis of information derived from the DABS sensor, uplink advisory information and maneuver commands to aircraft on potential collision courses.

The development of DABS has been divided into phases as detailed in the Engineering and Development Program Plan FAA-ED-03-1. Phase I of the program was initiated in January 1972 when Massachusetts Institute of Technology (MIT) Lincoln Laboratory was awarded a contract to develop an experimental model to demonstrate the feasibility of the DABS concept. This effort culminated in the development of DABS ER's which form the technical basis for the fabrication of the three Engineering Laboratory models.

Phase II started with the award of a contract to Texas Instruments (TI), the System Development Contractor (SDC) for fabrication of the three Engineering Laboratory (developmental) models of the DABS sensors and their delivery to and installation at three sites: the National Aviation Facilities Experimental Center (NAFEC); Elwood, New Jersey; and Clementon, New Jersey. The actual testing of these sensors under Phase II (DABS T&E) will be accomplished in four sub-phases: Factory Acceptance Tests, Field Acceptance Tests, NAFEC Performance Tests and DABS/ATC System Tests. The first two sub-phases (Factory Acceptance and Field Acceptance Tests) are the responsibility of the SDC with assistance being provided by Systems Research and Development Service (SRDS) and NAFEC. The latter two sub-phases (NAFEC Performance Tests and DABS/ATC System Tests) will be the responsibility of NAFEC. A detailed description of Phase II is provided in the DT&E Program Document, FAA Report RD-77-185 of December 1977.

The factory tests consist of unit, subsystem and system tests which are designed to comprehensively demonstrate that the delivered system meets the requirements specified in the ER. Unit tests apply to specific functional elements, e.g., receiver, transmitter, modulation control unit, or ATCRBS reply-to-reply processing. Subsystem tests apply to groups of related units which collectively support a sensor function, e.g., the Interrogator and Processor, Computer, and Communication Subsystems. System tests exercise the entire DABS sensor (to the extent possible at the factory).

Following acceptable factory acceptance testing, the contractor will deliver, install and demonstrate that the system meets requirements on site. Sensors will initially be field acceptance tested in the single-site mode. Testing activities will culminate in the three sensors operating in a netted, multi-site configuration.

Following government acceptance of the sensors, NAFEC will begin the DABS Performance test program. The overall purpose of these tests is to develop the technical information necessary to support a Technical Data Package (TDP). The testing of any modifications generated as these Performance Tests proceed will be completed prior to April 1980 and will be included in the April 1980 TDP.

Once the DABS single-sensor performance tests have progressed to the point where there is confidence in the ability of the sensor to meet system requirements, the sensor will be available to support DABS/ATC system testing. The basic purpose of the DABS/ATC system tests is to insure that the DABS adequately supports enroute and terminal ATC facility requirements; is compatible with these facilities from a functional performance standpoint; does not derogate ATC system performance, and identifies any improvements thereto. The results of these tests will be incorporated into separate TDP's and the planning associated with these tests will be the subject of separate test planning documents.

2.0 OVERVIEW

2.1 GENERAL

The purpose of these performance tests is to comprehensively evaluate the system-level performance of the DABS sensor operating in the stand-alone mode. In the stand-alone mode, assignment of sensor primary/secondary status and the management of DABS lockout for target handoff and acquisition of controlled targets is made by the associated Air Traffic Control (ATC) facility for controlled aircraft rather than by the Network Management function of the sensor. The characteristics of the sensor which will be evaluated include Surveillance, the Air-Ground Data Link, Channel Management, Network Management, Performance Monitoring and Communications. The functional performance of the DABS computers and the accuracy and resolution characteristics of each of the three sensors will also be measured. Finally, reliability and maintainability data on the three sensors will be collected and analyzed. The principal product of these performance tests will be the technical data that will be provided to Systems Research and Development Service (SRDS) for incorporation into a Technical Data Package (TDP) which will be handed off to the Operating Services by April 1980.

The above-listed characteristics will be evaluated by two categories of tests: functional and system. The system tests will begin with the System Baseline tests, which will augment the Factory and Field Acceptance tests to be conducted by the contractor. The primary purpose of the System Baseline tests is to establish a baseline of performance at the time of FAA acceptance and to identify any major problems within the DABS sensor hardware or software. At the completion of the System Baseline testing, modifications to the sensor hardware and software will be implemented and Baseline regression testing will be accomplished as necessary. Both the System Baseline and the regression testing will be completed prior to April 1980 and will be included in the April 1980 TDP. Parameter optimization and futher in-depth studies, including the detailed functional and system tests outlined in this document, will be conducted subsequent to April 1980.

A third test category, Subsystem tests, will also be performed, although largely on a time-permitting basis. These three test categories, (Subsystem, Functional and System), are described in sections 4.0, 5.0 and 6.0 respectively of this document. Within each category, each major test description contains an overview; a statement of objectives; a description of data collection techniques, results, and analysis; and resource requirements. The System tests category (section 6.0) also includes a description of the System Baseline tests which comprise initial System tests in all six functional areas.

A comprehensive overview of all of the Functional and System Tests is presented in section 2.2. Section 2.3 provides a comprehensive overview of the Subsystem Tests and section 2.4 provides the major test schedule milestones. As major test segments or areas are completed, the DABS Program Office shall be provided with the results and analyses of these tests.

Other test and evaluation efforts concerning the DABS sensor include Automatic Traffic Advisory and Resolution Service (ATARS), Data Link Utilization Tests, DABS/ATC System testing with both enroute and terminal facilities, DABS/ATCRBS Compatibility Testing and DABS/Mode 4 Compatibility Testing. Test plans for these efforts will be covered under separate documents.

2.2 FUNCTIONAL AND SYSTEM TESTS

The Functional and System tests will be run concurrently rather than sequentially. The essential differences between these two test categories are that the functional tests emphasize static inputs and simulated flight conditions while the system tests make greater use of dynamic inputs and flight testing. The specific tests are as follows:

2.2.1 SYSTEM BASELINE TESTS - The primary purposes of these tests, described in section 6.1, are to establish a baseline of performance for each sensor at the time of FAA acceptance utilizing those system adaptation parameters recommended by the contractor, and to identify any major system problems. The tests will consist of simulated inputs derived via the Aircraft Reply and Interference Environment Simulator (ARIES) and live flight data obtained from controlled flight tests. The ARIES is a unit of special test equipment that has the ability to simulate a heavy target and fruit environment for a DABS sensor. The ARIES test scenarios to be used in these tests will simulate a varied mixture of target information and environmental interference ranging from very good to very poor. Data from these scenarios will be collected via the System Data Extractor. The flight tests will be designed to define some sensor coverage for radial, orbital and close-in flights. In addition, range and azimuth accuracy measurements will be made by comparing target positions as reported by the sensor against precision tracking systems. These System Baseline tests will actually exercise all six functional areas in obtaining this baseline-level performance data.

2.2.2 SURVEILLANCE - The objectives of the surveillance tests are to determine the ability of the sensor to accurately report the predicted and actual spatial positions of aircraft targets and to adequately resolve two or more closely spaced targets. The functional surveillance tests (section 5.1) will utilize simulated static target information as inputs while the surveillance processing system tests (section 6.2) will utilize simulated dynamic targets and live controlled project aircraft to provide inputs to the sensor.

The static or functional tests will be conducted using both single and multiple simulated target inputs. The single targets will be generated by a Calibrated Performance Monitoring Equipment (CPME), which is a transponder-like device used to generate a target with a known fixed position; and also by the ARIES. Multiple targets will be generated by the ARIES. The functional tests will be conducted with various target input signal levels and simulated fruit and DABS environments. The data collected will be the positional target data sent to the ATC facility and the information content of the surveillance file. Key parameters will also be recorded. Surveillance functional performance will be characterized initially as a function of input signal level.

Once signal level performance is characterized, then functional performance as a function of the fruit and DABS environment will be determined. Specifically, plots of target accuracy and resolution, false targets, associated false tracks, and firmness number versus signal level, fruit and DABS environment will be made. If functional degradation is identified, the cause will be investigated. This will include analysis of system parameters and the environmental conditions employed during the test. The system adaptation parameters related to surveillance will be manipulated in order to increase and possibly optimize overall surveillance functional performance.

The surveillance processing system performance tests will utilize simulated dynamic targets via the ARIES as well as live controlled aircraft. Both simulated and live testing will utilize targets under various fruit and DABS environments; the simulated tests will also be made at various signal levels. Both types of testing will characterize dynamic single and multiple target performance and tracking capability. Areas of interest in the surveillance processing system tests include collimation and radar/beacon correlation; target detection; reflections; tracking performance using straight-line, turning, overtaking and crossing flight patterns; lockout features; and target reporting integrity. The data collected will be the track and position data in the surveillance file, track data via the Data Reduction and Analysis (DR&A) tapes, and target reports to the ATC facility.

2.2.3 AIR-GROUND DATA LINK - The functional performance tests (section 5.4) will evaluate the integrity of the 112-bit data link (DL) message code used in the DABS uplink and downlink DL messages, as well as the ability of the DABS sensor to correctly process simulated messages for which the transmission parameters are selectively varied. The system performance tests (section 6.4) will fully evaluate the DABS DL operation in an actual live environment using aircraft equipped with DABS transponders under conditions of normal channel interference.

The first objective of the functional tests involves the evaluation of the DL code itself, hence does not require an actual DABS sensor or transponder. Due to the large number of possible error combinations, considerable testing time is required to comprehensively test the error detecting and correcting capabilities of the code. Therefore, the evaluation of the code itself will be accomplished by means of a bench test in which the DABS error detection and correction circuitry will be simulated by a breadboard-type code tester controlled by a microprocessor. This bench test can, therefore, be started before the delivery of the actual DABS sensor to NAFEC. These tests will determine whether the error detection and correction capability of the DL code, which is known to perform properly for a 72-bit message length, will perform properly for the standard 112-bit DL message.

The microprocessor will have the capability of imposing error bursts 24 bits or less in length anywhere within a standard size 112-bit DL message. All possible combinations of these error bursts will be generated. The bench tests will determine whether (a) all uncorrupted messages will be accepted, (b) all induced errors within specified limits will be detected, and those errors occurring in low confidence level bit positions will be corrected, and (c) messages containing errors outside the specified limits will be rejected.

The second objective of the functional tests involves the inputting of simulated DL messages from the ARIES or Test Target Generator (TTG) into the DABS sensor. These simulated messages shall utilize the bit configuration most susceptible to adverse conditions as determined from the code tests. The transmission parameters to be varied include frequency, signal strength, and monopulse Δ/Σ ratio. These tests will determine the optimum transmission parameters for the DL messages and the optimum link reliability.

The system performance tests will measure link reliability, which is an index of DL performance and is defined as the ratio of the number of correctly received messages to the total number of messages transmitted. Measurement of link reliability requires that each uplink and downlink message be uniquely identified both at the point of origin and at the point of reception. This is done by inserting a unique message identification (ID) number in each message, together with a time code. These message ID numbers are generated by the ground equipment for uplink messages and by an airborne microprocessor for the downlink messages. In addition, airborne equipment will record the aircraft flight characteristics for each interrogation message and reply message processed by the transponder. This will enable correlation of the airborne data with the data collected on the ground.

Airborne and ground recorders will provide a permanent record of each transmitted and received message both at the sensor and in the aircraft. By noting the aircraft flight characteristics recorded on the airborne data, factors such as desensitization of the transponders due to interrogation by other sensors, uplink multipath problems, and airborne antenna shading during aircraft maneuvers can be noted and controlled. In this way, all external parameters can be eliminated or controlled except the normal interfering signals existing on both uplink and downlink channels. These interfering signals represent the normal operating environment.

Comm A and Comm B interrogations and replies will be used for characterization of the air-ground data link.

2.2.4 CHANNEL MANAGEMENT - The performance of the DABS greatly depends on the efficient use of the RF channel, which is regulated by the channel management function. The functional performance tests for channel management (section 5.3) will (1) determine whether the channel management function has been implemented as specified in the ER, (2) will determine the performance of channel management with respect to the efficient use of the RF channel under simulated conditions, and (3) will characterize and evaluate channel management performance in terms of its ability to successfully schedule transmission under varying traffic conditions and message types. These functional tests will be performed using controlled simulated inputs. Channel management system tests will not be performed per se, however, the dynamic performance of the channel management function will be observed in the Surveillance Processing system tests (section 6.2), for which a comprehensive overview is presented in section 2.2.2.

The functional tests will be accomplished in two phases. Phase 1 will consist of desk checks of the channel management programs to verify compliance with the ER. Several test scenarios will be loaded into the memory as inputs to the individual channel management tasks. These tasks consist of Transaction Preparation, Target List Update, Roll-Call Scheduling and Transition Update. Phase 2 of the functional tests will consist of stand-alone tests for all channel management functions interacting with each other by means of test drivers and ARIES scenarios. After data extraction, this data will be used as inputs to the channel management analysis programs. These programs will determine the performance and functional capability of channel management in terms of its capability to process the maximum number of targets for both homogeneous and peak loading traffic densities.

2.2.5 NETWORK MANAGEMENT - The purpose of both the functional and system tests for Network Management is to determine the adequacy with which Network Management performs its functions of insuring adequate surveillance and communications service. These functions will be evaluated for aircraft in the coverage airspace of a DABS sensor in the standalone mode with overlapping coverage configuration. This mode of sensor use is a subset of the total Network Management capability of netted sensor operation which is to be evaluated at the completion of standalone testing. The functional tests (section 5.5) will evaluate the functions of Network Management (as they apply to the standalone mode with overlapping coverage configuration) under a variety of input conditions derived from specific test scenarios. The data extraction software will be used to record the appropriate input and output data on magnetic tape for further offline DR&A. The specific data to be collected include the surveillance file for each target in the system, the coverage map and reference subfiles in the map, (such as DABS lockout Transition Control, Sensor Primary/Secondary state, lock count) and the messages which were generated and/or received. Three areas of testing will be involved in the functional tests. The first area is concerned with simulated uncontrolled DABS aircraft which change track status and cross cell boundaries. The second testing area concerns controlled DABS aircraft which enter sensor overlap areas and receive aircraft control state assignments from ATC. The third area is concerned with adjacent sensor failure and recovery.

The data collected from the Network Management list in the surveillance file will be tabulated by scan for each aircraft and for each function tested. The data will then be compared for accuracy with the expected results which will be independently determined.

The system tests (section 6.6) will use two or three sensors operating simultaneously in the standalone mode with overlapping coverage configuration. Simulated targets from ARIES will be inputted to one of the sensors for test and evaluation of the coverage map, lockout management and aircraft control state. Scheduled flights will be used to provide a controlled target input to the sensors. One of the sensors will be site-adapted primary through the entire coverage area in order to evaluate totally isolated sensor operation. Then the adapted parameter will be changed so as to allow the sensor to follow average map assignments and aircraft control state inputs from the air traffic control facility.

The data from each of the sensors will be presented on the display as well as recorded on magnetic tape at the System Test Console (STC). The STC will also be used to simulate an ATC facility by transmitting messages from aircraft to the appropriate DABS sensor. All STC messages both sent to and received from each of the sensors will be recorded for subsequent processing. The specific data to be collected at the sites are the surveillance files for each aircraft, target reports which would be sent to Intermittent Positive Control (IPC), the coverage map, the aircraft control state and the priority messages which were received from the STC or the target report messages which were generated. The specific data to be collected at the STC include the time of the priority assignments for each aircraft in the system and the surveillance messages which were received from each of the sensors.

The areas of testing for the system tests will be similar to those for the functional tests except for the simulation of ATC messages by the STC. The tabulation of the processed data will also be similar to that employed for the functional tests, with the additional listing of the correlation of the surveillance messages sent to IPC at each of the operating sensors to the number of target reports per scan.

2.2.6 PERFORMANCE MONITOR/FAILURE RECOVERY - The functional tests (section 5.2) are intended to determine compliance of the performance monitoring and failure recovery functions designed into the sensor with the specifications defined in the ER. The functional tests are also concerned with parameter optimization and the determination of grey zones and ambiguities in the measured parameters. This will be accomplished by varying selected parameters using both simulated scenarios and live flight tests. The system tests (section 6.5) are concerned with observation of sensor operation during the overall period of the Performance Tests with no parameter variations.

In the functional performance tests, compliance with ER will be ascertained for the hardware and software monitors and also for failure mode performance. Computer printouts of the generated status messages and failure mode indications shall be collected to verify that the performance monitor hardware and software parameter measurements are in accordance with ER-240-26. Computer data shall be collected and evaluated to determine the satisfactory range of operation, region of ambiguity, and unacceptable limits of certain predetermined parameters. Status message printouts shall be analyzed to ascertain the effect different failure modes (introduced during the testing) have on sensor operation.

The failure/recovery tests shall be designed to establish the performance of a sensor with respect to providing surveillance processing service. The quality of the surveillance data will be established by comparing sensor performance with that achieved with no failures, using the criteria established by the surveillance processing system tests (section 6.2) as a basis of comparison.

Parameter optimization will be performed by using scenarios with known tracks, targets, reports and other inputs; and live flights for which the output data is documented. Selected parameters of both hardware and software monitors will be varied, using both scenarios and flight tests.

In the system tests, status message information will be collected on a continuous basis at all times during DABS usage. This information will be collected in a site log which will also include any indication of impending outage which did not show in the status message content. Among the information which these system tests will generate are included (1) stability of the monitor, (2) the parameters to be remoted, (3) adequacy of the performance monitor in maintaining operation at an unmanned facility (4) failure modes that result in a reduction of DABS functions, and (5) additional parameters which should be measured and reported.

2.2.7 COMMUNICATIONS - The functional tests (section 5.6) will evaluate the data paths of the entire communications subsystem and will determine the performance characteristics and design adequacy of the communications software. This will include verification of the CIDIN message processing, surveillance message processing, front end processing (FEP), message routing and data link processing.

The functional tests will rely primarily on the collection and analysis of communications messages and files. A software program known as a driver will reside in a spare DABS computer providing updates and extracting data during the tests. Messages will be tested in both the NAS-to-DABS and DABS-to-NAS data transmission configurations. During these tests, message formats will be varied and error logic invoked to ensure proper operation.

The data collected during the functional tests will be communications messages, files, and software parameters recorded on magnetic tape. At the conclusion of each test, the contents of the tape will be printed and compared with the expected results. Any software or ER discrepancies will be corrected and tested again for proper operation. Inputs will be varied to insure correct and incorrect message parameter construction. Statistical data will be maintained on errors encountered during data transmission within the sensor communications subsystem. Additionally, the sensor data transfer capabilities (message transfer rate) will be calculated.

The system tests (section 6.7) will emphasize data flow from the external ATC facilities to simulated aircraft. During these tests, known scenarios will be provided from the ARIES and Interface Verification Software. Sensor communication lines will be connected to and monitored by the SSF 9020 and TATF ARTS III. Various combinations of active telephone lines, aircraft traffic loads, and communication message loads will be used. Tests will include operation of the communication links under both normal and error conditions. Specific attention will be given to operation during periods of link switching.

During each test, the data transmitted and received on each of the communication links will be recorded at both the sensor and the ATC facilities. Recording at the sensor will be accomplished utilizing the data extractor. Recording at the ATC facilities will be accomplished utilizing the Interface Verification Software.

ARIES scenarios for several different traffic loads will be utilized to control the load on the surveillance links. CIDIN Communication Scenarios with varying mixtures and numbers of communications messages will be used with the Interface Verification Software to control the data load on the CIDIN links.

The data collected will be reduced and the sensor data compared to the SSF and TATF data. Bit error rates and message error rates will be calculated for each link for each load condition.

On the surveillance links, time in storage and unsuccessfully transmitted messages will be analyzed. On the CIDIN communication links, retransmission rates and response time delays will be analyzed. This will include an overall analysis of the adequacy of the CIDIN protocol. In particular, data occurring during periods preceding and following link switch operation will be studied.

2.2.8 COMPUTER FUNCTIONAL TESTS - These tests, described in section 5.7 will be conducted in order to evaluate the performance of the several DABS computers used throughout the DABS sensor and to characterize the distributed processor architecture. A combination of hardware monitoring and software monitoring techniques will be used to collect data on the performance of these computers. In addition, the operational suitability of the voting computer concept will be evaluated.

2.2.9 ACCURACY AND RESOLUTION TESTS - These system tests (section 6.3) are intended to determine the system accuracy and resolution characteristics of each of the three DABS sensors for ATCRBS and DABS transponder-equipped aircraft operating within the NAFEC test environment.

ACCURACY, which is defined as the capability of DABS to report the correct position of an aircraft target, will be determined by comparison between DABS surveillance data and reference data obtained simultaneously from a NAFEC precision aircraft tracking system. The difference (or error) will be tabulated in both rho/theta and X-Y coordinates and statistically analyzed for specific increments in range, azimuth, altitude, and elevation angles relative to the sensor coordinates.

RESOLUTION is defined as the ability to accurately detect and track two aircraft that are in close proximity. This will be determined by comparing target and track data derived from the DABS sensor to aircraft separation as measured by two precision aircraft tracking systems at NAFEC. Using DABS surveillance data, analysis will include the calculation of aircraft separation values which will then be compared with aircraft separation values obtained from the reference tracking systems.

During all tests, DABS surveillance data will be recorded continuously on magnetic tape at both the sensor and ATC terminals. Extraction of those messages related to the test aircraft will be accomplished by the use of discrete beacon codes assigned to the aircraft during the test period. Reduction and analysis of the data will be accomplished utilizing the NAFEC general purpose computer (Honeywell 66/60) which has been programmed to provide the statistical expression of the accuracy and resolution capability of the DABS sensor.

2.2.10 RELIABILITY AND MAINTAINABILITY TESTS - The main purpose of these tests (section 6.8) is to uncover weak points or problem areas in the system design. These take the form of distinct or repetitive hardware failure patterns, together with any unusual difficulties encountered in isolating and correcting such failures. The reliability and maintainability evaluation, therefore, will consist of observing the operational status, failure, and maintenance histories of each of the three sensors for a period of at least six months per sensor. The evaluation will not require the imposition of specific tests or scenarios but will begin at the same time that the other performance tests outlined in this Test Plan start and will run concurrently with all DT&E effort at NAFEC. Data collection will consist of recording any changes in operational status of the equipment and recording a complete history of every hardware failure which occurs in each of the three sensors.

Each sensor is broken down for reliability purposes into over 200 individual reliability elements. A complete and comprehensive running account of the operational status, failure, and maintenance histories of each of these reliability elements will be provided by use of automated techniques. Specifically, each hardware failure history will be identified with the appropriate reliability elements and encoded onto punched cards for data processing. This will result in a continuous failure and maintenance history of over 200 reliability elements for each sensor, thereby, enhancing the recognition of distinct or repetitive failure patterns.

Using this failure and maintenance history, a secondary objective can be attained, namely, a determination of the Mean Time Between Failures (MTBF) and Mean Down Time (MDT) of the DABS Sensors. These are figures of merit, or numerical indexes, of the overall system reliability and maintainability respectively. They will be obtained through the use of mathematical models, using the element failure and maintenance data as inputs.

2.3 SUBSYSTEM TESTS

The subsystem tests address the Interrogator and Processor (I&P) subsystem, the Data Extractor subsystem, the various digital interfaces to the sensor, and the Avionics Subsystem. Overviews for these four subsystem test areas are presented in sections 2.3.1 through 2.3.4 respectively.

2.3.1 I&P SUBSYSTEM TESTS - The I&P subsystem includes five major subdivisions: the antenna, the transmitter, the receiver, the DABS Reply Processor and the ATCRBS Reply Processor. Individual overviews for the tests designed for each of these five sub-areas are presented in sections 2.3.1.1 through 2.3.1.5.

2.3.1.1 ANTENNA - Each of the three DABS sites will have a different antenna configuration. The NAFEC site will have an ASR-7 radar and four dipoles placed around the horn, i.e., integral beacon feed. The Elwood site will have an ARSR-2 radar and the beacon will consist of two back-to-back open-array antennas. The Clementon site will consist of an ASR-8 radar and an integral beacon feed of eight dipoles. However, shortly following initial installation of the sensors, the antennas at the NAFEC and Clementon sites will be supplemented by open-array antennas. Accordingly, minimal tests, if any, will be conducted using the ASR-7, -8 integral feed modifications.

Each antenna configuration consists of three channels, each of which has a different azimuthal coverage pattern and gain. These channels are: the Sum (Σ) or directional pattern, the Difference (Δ), or antisymmetrical pattern and the Omnidirectional (Ω) pattern.

The antenna tests to be conducted (section 4.1.1) will consist of a theoretical analysis, static or solar tests, and flight tests. Data will be collected with each antenna disconnected from the DABS site in order to define and verify areas of obstruction, reflections, and diffraction unique to the antennas.

2.3.1.2 TRANSMITTER - The purpose of the transmitter tests (section 4.1.2) is to ascertain the technical characteristics of the Transmitter and the Modulation Control Unit for both the ATCRBS/DABS All-Call and the DABS Roll-Call types of interrogations. While the Modulation Control Unit is physically part of the Processor, it will be considered functionally as part of the Transmitter for the purpose of these tests. These tests will furnish information on such parameters as frequency stability, peak and average power outputs, pulse characteristics and electromagnetic compatibility. The test results will be subjected to data reduction and analysis which will identify acceptable ranges of operating parameters as well as problem areas.

2.3.1.3 RECEIVER - The purpose of the receiver tests (section 4.1.3) is to determine the operating parameters of the receiver and the performance of the monopulse receiver video outputs. Data for each of the sum, difference and omni receiver channels will be obtained and recorded. Tests will also be performed to determine the operating characteristics of the video quantizer. Data reduction and analysis programs will indicate the performance of the various receiver parameters, including sensitivity, dynamic range, bandwidth, pulse characteristics and monpulse accuracy.

2.3.1.4 DABS REPLY PROCESSOR - The purpose of these tests (section 4.1.4) is to define the performance of the critical elements which comprise the DABS Reply Processor. These elements are: video digitization, message bit and monopulse processing, and error detection and correction.

Three functions of the video digitization element will be tested. These are: (1) lead and trail edge detection, which will be tested by inserting rf test pulses which are variable in time and amplitude, (2) preamble detection, which will be tested using a CPME to generate DABS replies, and (3) monopulse analog-to-digital converter calibration, which will be tested using a square-wave generator.

The message bit and monopulse processing element will be tested using 56- and 112-bit messages generated by a CPME and/or an ARIES. The error detection and correction element will be tested using the same test configuration.

2.3.1.5 ATCRBS REPLY PROCESSOR - These tests (section 4.1.5) are designed to identify the static performance of the ATCRBS Processor. Identification of the characteristics of the variable parameters of this unit is the main purpose of these tests. The specific subfunctions to be tested include the Lead and Trail Edge estimators, Bracket Detection, Reply Processing and Garble Recognition. These subfunctions will be tested as functions of the variable parameters of the ATCRBS Reply Processor, using the Test Target Generator as the source of target information for these tests. Optimization of each variable parameter will result from this set of tests.

2.3.2 DATA EXTRACTION SUBSYSTEM - The purpose of these tests (section 4.3) is to evaluate the performance of the four functions of the Data Extraction Subsystem. These functions are: (1) data extraction, (2) quick-look, which provides timely listings of selected portions of recorded data, (3) playback, wherein previously recorded reply data are inputted to simulate the front end of the sensor, and (4) extended analysis. These functions will be tested via various scenarios inputted from the ARIES.

2.3.3 INTERFACES - The evaluation of the interfaces (section 4.2) will consist of tests to be conducted on the hardware elements which comprise the digital interfaces to the DABS sensor to ensure proper operation.

The emphasis during these tests will be on an evaluation of the compatibility between the hardware being provided with the DABS sensor and the existing hardware at NAFEC with which it interfaces.

These tests will include the Telco lines, Modems, Communications Multiplexer Controller, Surveillance links to the ATC Facilities, CIDIN link to the TATF, and Primary Radar Interface.

Tests of the protocol between the sensors and the ATC Facilities will be conducted during the Communication System tests. (See section 6.7.)

2.3.4 AVIONICS - Evaluation of the avionics subsystem (section 4.4) is not an objective of the DABS T&E program. However, to assure reliable test data on the DABS sensor, it is essential that the avionics be evaluated before starting the DABS flight tests. With the aid of the transponder test set (being designed and built by NAFEC) a thorough check of the DABS transponder shall be accomplished. In addition to the checks of the RF section, a series of prerecorded messages in the various interrogation modes shall exercise the transponder circuitry. The tester shall be designed and configured to facilitate transponder evaluation on the flight line so as to assure that this vital link is functioning in accordance with the DABS National Standard prior to committing expensive flight time. In addition, any available displays or extended length message devices shall undergo testing so as to assure that the avionics subsystem is functional at a level commensurate with the DABS.

2.4 OVERALL SCHEDULE

Figure 1 shows the major milestone schedule for the overall DABS T&E effort. The detailed schedules for each of the three sites are shown in section 10.

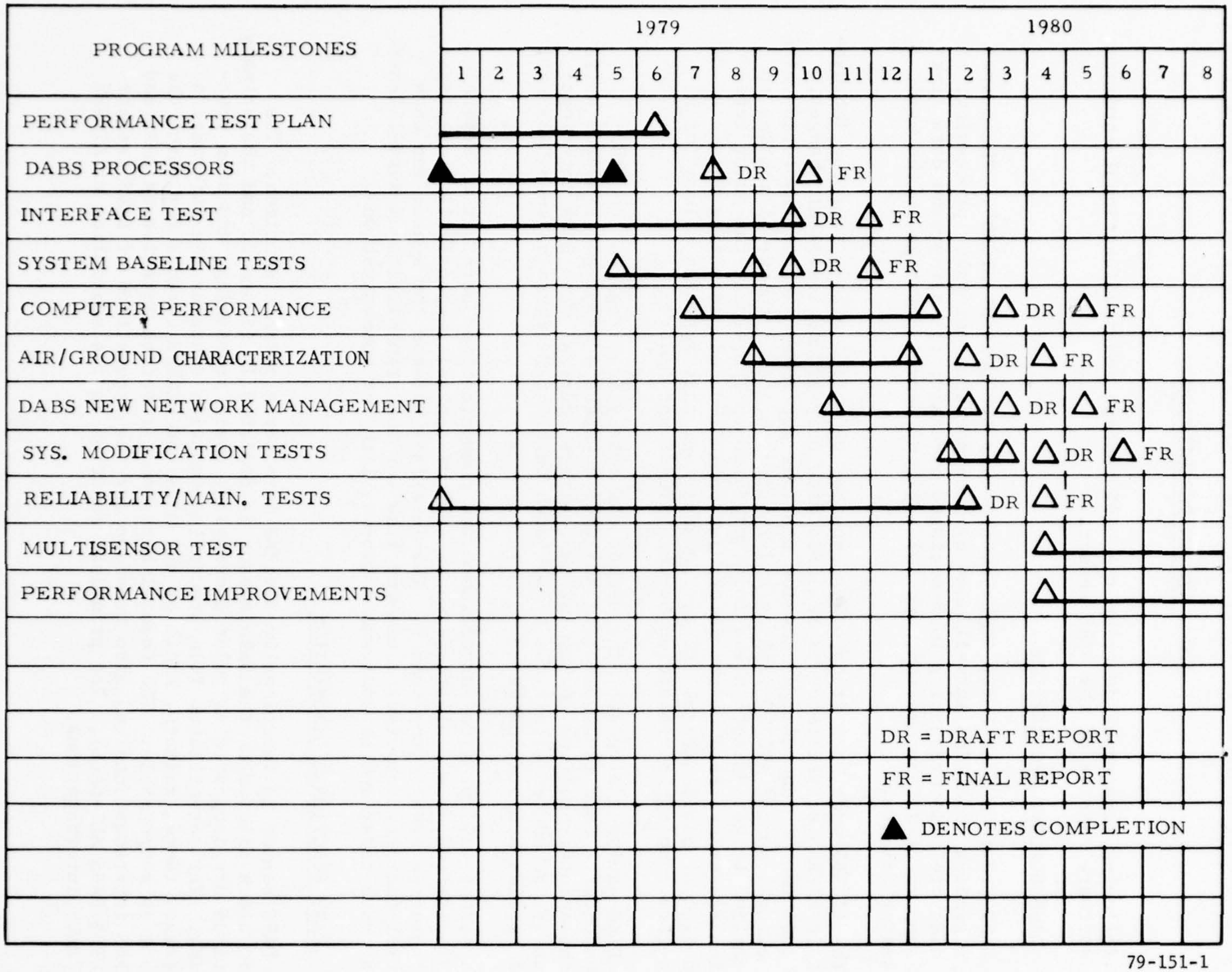


FIGURE 1. MILESTONE SCHEDULE FOR OVERALL DABS T&E EFFORT

3.0 SYSTEM DESCRIPTION

The following paragraphs describe the DABS concept and the functional hardware and software aspects of the DABS sensor.

3.1 DABS CONCEPT DESCRIPTION

The DABS provides four basic improvements over the present ATCRBS. These are: (1) upgrading of ATCRBS surveillance by incorporating monopulse processing; (2) discretely interrogating DABS-equipped aircraft; (3) air-ground data link for support of ATC automation, and (4) adjacent sensor coverage in the event of sensor failure.

In the ATCRBS mode, the transponder requires no modification, thus the improvement in ATCRBS surveillance is realized with only ground equipment changes. The addition of monopulse processing provides for more accurate resolution of two closely spaced ATCRBS replies and requires a lesser number of replies to accomplish target detection and code validation. Therefore, the pulse repetition frequency (PRF) of the interrogation is reduced, resulting in a reduction of environmental fruit. In addition, this approach allows for a long-term compatible transition between ATCRBS and DABS.

For DABS-equipped aircraft, the sensor discretely interrogates the DABS transponder. Each transponder is assigned a unique address and responds only to those interrogations containing that unique address. The DABS interrogations are scheduled within the sensor such that interference between DABS roll call replies are precluded.

Each sensor will provide surveillance and communications services to several ATC facilities, i.e., all those whose area of control responsibility overlaps the coverage area of the sensor. The interface between the sensor and each control facility comprises a one-way link for the transmission of surveillance data, both radar and beacon; and a two-way link for communications.

3.2 DABS FUNCTIONAL DESCRIPTION

The DABS sensor is functionally divided into three primary sections. The basic block diagram of the DABS sensor is depicted in figure 2, and the primary sections are indicated as pulse processing, dwell processing, and scan processing. The surveillance file processing function contains the information (address, range, azimuth, etc.) of all DABS and ATCRBS targets for which the sensor is responsible. The Channel Management function interleaves DABS and ATCRBS interrogations and also provides for the acquisition of DABS targets (ATCRBS/DABS ALL-CALL). Its principal function is the scheduling of ATCRBS and DABS interrogations.

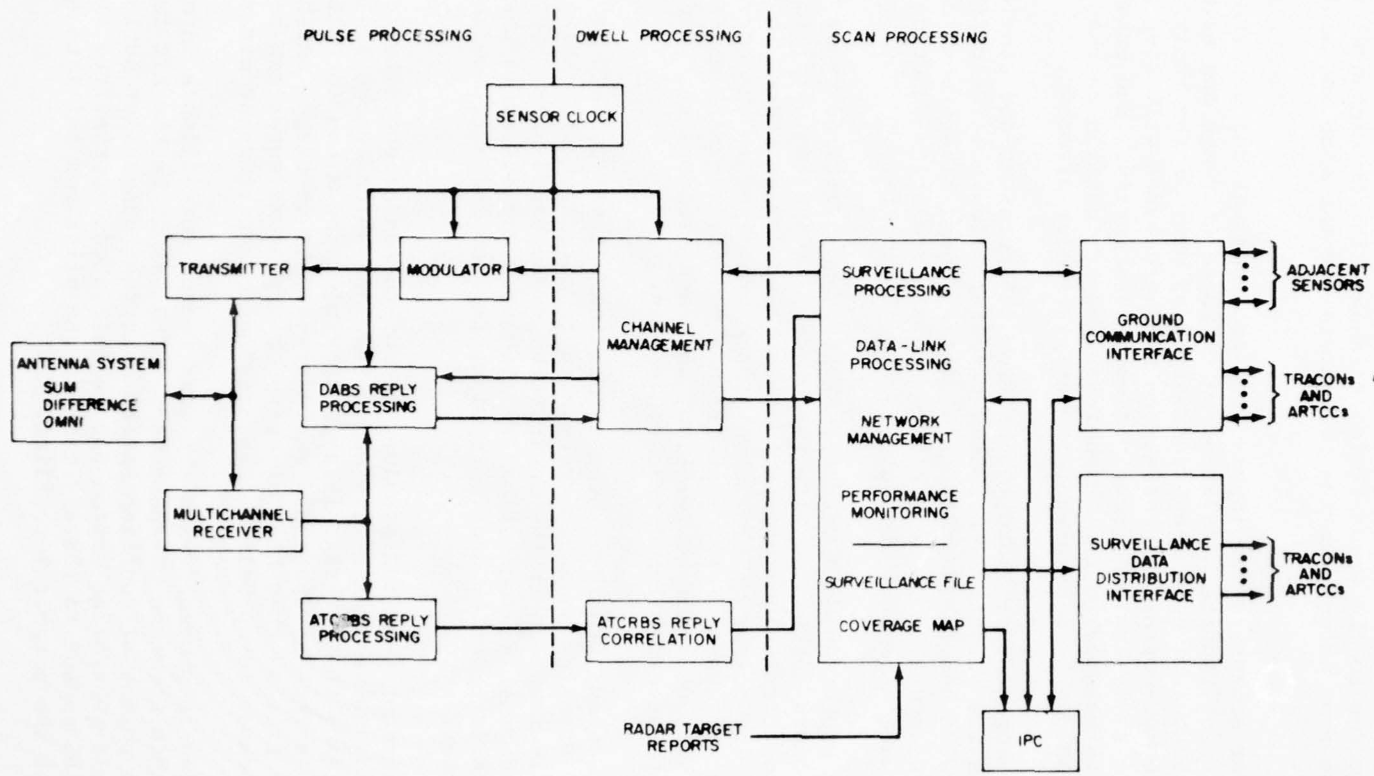


FIGURE 2. DABS SENSOR FUNCTIONAL BLOCK DIAGRAM

The Transmitter-Modular Control produces all waveforms and RF signals in ATCRBS and DABS modes to the transmitting antenna. The multichannel receiver provides the path from antenna to the processors for the DABS and ATCRBS aircraft replies.

The DABS processor accepts video inputs from the receiver and declares DABS targets. DABS target reports consist of an estimate of range and azimuth, and the information bits that have been transmitted as part of the reply. Using error flags and error-correcting codes, the DABS processor will give an indication whenever a reply has been received unsatisfactorily. The unsatisfactory reply condition is relayed to the Channel Management function so that another DABS interrogation can be scheduled for that particular aircraft.

The ATCRBS processor accepts video inputs from the receiver and provides ATCRBS target replies as its output. The ATCRBS target replies consist of the range, azimuth, one of 4096 beacon identify or altitude codes, ATCRBS confidence, monopulse average, and time. The reply-to-reply correlation function is performed by a software algorithm and outputs target reports.

The surveillance processor accepts DABS, ATCRBS, and digitized radar reports. The radar reports are correlated with the beacon (ATCRBS and DABS) target reports and these correlations are further correlated with tracks in the surveillance file. The output of the surveillance processor is the surveillance data stream from the sensor. The surveillance reports are DABS and ATCRBS reports with or without radar correlation, and radar reports that did or did not correlate with an established track this scan.

The DATA Link processor provides the message link between the ATC facilities and the sensor. Downlink messages are passed to data link processing where the information is fowarded to the designated ground-based user. Uplink messages sent from the ATC facilities are formatted and listed in the data link file with their priority and appropriate tags to indicate how soon they should be forwarded.

The Network Management function provides sensor-to-sensor coordination. This function reads the surveillance file and determines which tracks are active in the sensor, reads the coverage file to determine the areas for which this sensor has been assigned primary and secondary sensor coverage, and has access to the data link file so that high priority or urgent messages can be handed to an adjacent sensor for parallel transmission to a particular aircraft.

The ATARS function is provided with the most recent surveillance information on all aircraft within coverage of the sensor. The output to the ATC facility indicates that a potential conflict exists such that controller action can be initiated. Should controller action not be initiated, appropriate signals are sent from the DABS sensor to the aircraft so the pilot can initiate evasive action to prevent the potential conflict.

Sensor performance monitoring is accomplished both by measurements within the sensor and loop measurements between the sensor and the remotely located calibration and performance monitoring equipment (CPME). The CPME will reply to special test interrogations. The replies will be compared with certain constants that have been stored to determine whether the sensor is performing properly.

Additional functions which are to be incorporated into the DABS sensor are the processing and display of reconstituted video, raw video and radar tracking.

Reconstituted video provides for the conversion of certain DABS surveillance messages into rho-theta ATCRBS beacon, radar and weather formats for use on time-shared displays such as the ARTS III Data Entry and Display System (DEDS). This function is to be accomplished through a video reconstitutor, which is an independent self-contained unit which can be located at the DABS sensor or at the ARTS III ATC facility. The video reconstitutor shall also provide Azimuth Change Pulse (ACP) and Azimuth Reference Pulse (ARP) outputs referenced to the azimuth of the reconstituted video signals. The video reconstitutor shall provide video switching capability to select between reconstituted video in the normal mode and raw beacon and radar video in the back-up mode. In addition, the Clementon sensor will have the capability of delaying the primary radar video to provide registration with the output of the video reconstitutor.

The DABS sensor will also have the capability of being interfaced to a Moving Target Detection (MTD) device or a Radar Data Acquisition Subsystem (RDAS). This will replace the common digitizer (CD) radar interface providing improved radar data for use in radar beacon correlation and radar tracking.

A more detailed description of sensor functions is provided in FAA-RD-74-189 (ATC-42).

3.3 DABS HARDWARE DESCRIPTION

The physical DABS sensor consists of three major subsystems: The Interrogator and Processor (I&P) subsystem, the Computer subsystem and the Communications subsystem. A fourth subsystem, the Data Extraction subsystem, extracts and analyzes the data produced by the three major subsystems of the sensor.

The I&P subsystem consists of the Antenna, Transmitter, Receiver and Processor Units. This subsystem accomplishes the Pulse-Processing function depicted in figure 2 essentially through hardware.

The Computer subsystem consists of 32 DABS computers, together with Global Memories and interconnecting hardware. The internal processing functions of the sensor, including Channel Management, Surveillance Processing and Network Management are accomplished by software which resides in this subsystem.

The Communications subsystem includes three DABS computers along with the various interface circuitry and modems required to prepare and transit the processed surveillance and communications or data link messages between the DABS sensor and the ATC facilities with which it interfaces.

The three major subsystems are described in sections 3.3.1, 3.3.2, and 3.3.3 respectively.

3.3.1 I&P SUBSYSTEM - The hardware in the pulse and dwell processing functional areas is contained in the I&P racks. There are three unique equipment racks in the I&P area: Transmitter, Receiver, and the Processor racks. Figure 3 shows the equipment cabinets of the I&P subsystem.

A full dual system is obtained by using two transmitters, two receivers, and one dual processor cabinet. The antenna consists of a single beacon antenna or, for enroute sites, two antennas pointing in opposite directions (back-to-back) in order to provide a higher surveillance update rate to support ATARS.

3.3.1.1 ANTENNA - The following paragraphs describe the antennas in use at each of the three test sites.

At the NAFEC site an ASR-7 radar antenna with integral feed is used. The beacon antenna consists of dipole elements arranged symmetrically around the main radar horn. The omni antenna for side lobe suppression (SLS) transmissions and receptions is a 5.5-foot vertical slot-type antenna.

At the Clementon site an ASR-8 radar antenna with integral feed is used. The beacon signals use symmetrically arranged dipoles around both horns. The omni antenna is a vertical slot-type antenna. Both the NAFEC and Clementon sensors will be upgraded with a single 5-foot open array that includes an integral omni antenna.

At the Elwood site, the primary radar antenna is the ARSR-2 system. The beacon utilizes two back-to-back open-array antennas. The omni antenna is an integral part of the open array designed to match the vertical pattern of the beacon array.

3.3.1.2 RECEIVER - The receiver is a multichannel monopulse receiver. The receiver inputs from the antenna are the sum (Σ) and difference (Δ) signals from the beacon antenna and the signal from the omni antenna (Ω). The signals pass through a blanking switch which is used to short the inputs during test time, which is the time between reply or listening windows. The receiver is subjected to precise, internally-generated RF signals between returns under the control of the Processor.

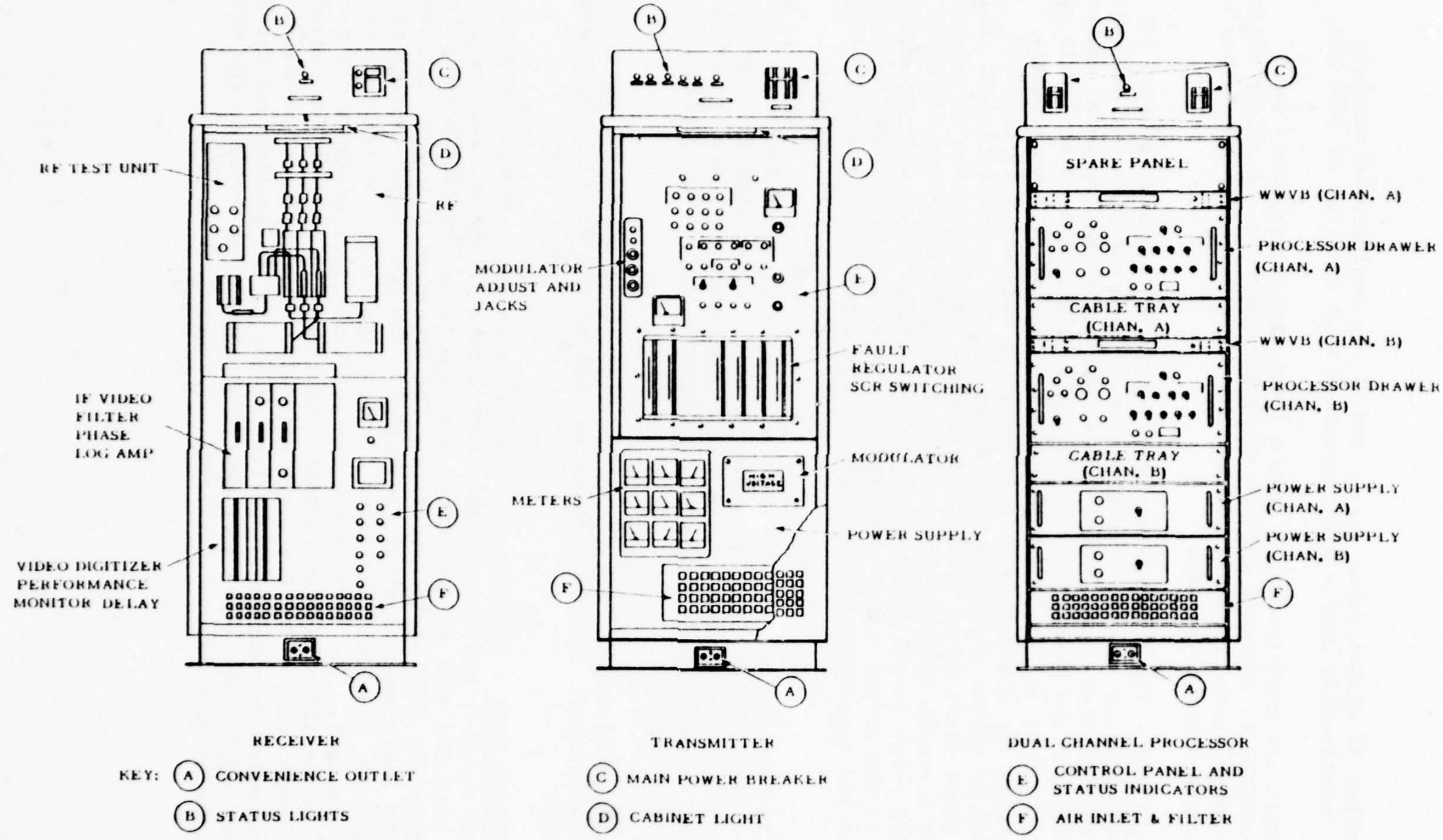


FIGURE 3. EQUIPMENT CABINETS OF INTERROGATOR AND PROCESSOR SUBSYSTEM

The three parallel RF signal paths (Σ, Δ , and Ω) are designed to maintain precise phase relationship over a wide frequency band centered at 1090 MHz.

After the signals are converted by a common local oscillator, the Σ and Δ signals are combined to generate the Δ/Σ monopulse envelope. A linear relationship exists between monopulse amplitude and the angle formed by the target's position and the antenna boresight.

3.3.1.3 TRANSMITTER - The transmitter produces the RF signals required for both DABS interrogations and SLS transmissions. These comprise the MAIN and SLS outputs respectively. Both output modes have high- and low-power options under the control of the Modulation Control Unit (MCU). The power levels are determined by the duty factor of the MAIN output mode or by the particular situation existing for a given interrogation. The modulation of the MAIN output mode may be either amplitude modulation (AM) or a combination of AM and differential phase shift keyed (DPSK) modulation. The modulation is selected to interrogate aircraft equipped with either ATCRBS- or DABS-type transponders. The transmitted power levels are monitored, and a video pulse with an amplitude proportional to the output power is routed to the receiver for conversion to a digital byte and consequent retransmission to the performance monitor (PM) unit.

A number of discrete digital signals representing marginal or failed transmitter operations are transmitted directly to the PM unit. Other signals, representing conditions when the transmitter is unavailable for operation, are transmitted to the PM unit. These signals are also displayed by lights on the front panel of the transmitter cabinet.

The MCU card, located in the DABS processor cabinet, is considered an integral part of the transmitter. Testing procedures combine the MCU with the transmitter for convenience.

3.3.1.4 PROCESSOR UNIT - The Processor Unit accepts logic levels and monpulse video from the receiver and detects and decodes both ATCRBS and DABS replies. This is done with two sets of circuitry; one comprising the ATCRBS Reply Processor, the other the DABS Reply Processor. The Processor Unit also includes the MCU and the Performance Monitor Controller. The MCU, under control of the computer subsystem, provides modulation control signals to the transmitter during interrogations. The Performance Monitor Controller collects all performance data from the I&P subsystem elements and transmits them to the computer subsystem for processing. The Processor Unit also physically accommodates the WWVB Receiver, which provides accurate time of day to the System; and the Uninterruptable power supply, which provides emergency sustaining power to the WWVB receiver in case of primary power failure.

3.3.2 COMPUTER SUBSYSTEM - The computer subsystem consists of 32 DABS computers together with two Global Memory units and interconnecting hardware. This subsystem, shown in block diagram form in figure 4, is physically accommodated in five equipment cabinets. Each of the 32 computers consists of two identical arithmetic and logic (AU) circuit boards, an 8K local memory board and a voter board which compares the outputs of the two AU boards and takes the computer out of the system should the AU outputs not compare. When this occurs, a redundant computer is brought on line to perform the same functions.

The circuit boards comprising the computers are contained in drawers, each of which can accommodate up to four computers. The 16 circuit boards comprising these four computers are called a computer ensemble and are plugged into a Tiline, which is a motherboard or master circuit board. In addition to the computer circuit boards themselves, the Tiline also accommodates associated circuit boards such as couplers, interface boards and a priority control board.

Each drawer of four computers is energized by a 5-volt triplex power supply drawer located directly underneath. This drawer contains three identical 5-volt power supplies, any two of which can maintain the associated computer drawer operational.

Two of the 32 computers are used to process inputs from the ATCRBS Reply Processor. These are called ATCRBS Computers. One of these is on line, the other is a redundant standby. The remaining 30 computers process data sent from the DABS Reply Processor, the MCU, the Performance Monitor, and the Azimuth System Timing Unit (AZSTU), all of which are in the I&P Subsystem; as well as communications messages inputted from ATC facilities. These 30 computers consist of seven ensembles of four computers apiece with the remaining two computers located in the drawer containing the two ATCRBS computers. Twenty-six of these 30 computers are required to maintain the system operational.

Global memories A and B each consists of a Tiline to which are attached several strings of memory elements, each of which totals 176K words. One global memory contains two sets of 176K memory strings while the other global memory contains one such set. Each global Tiline with its attached 176K memory strings is physically housed in a global memory drawer which is energized by a 5-volt triplex power supply drawer located directly underneath.

Data are transferred between the various ensemble Tilines, the ATCRBS Tiline, the Global memory Tilines and between the Computer and Communications subsystems by means of coupler pairs. The arrangement of these coupler pairs is shown in figure 4.

3.3.3 COMMUNICATIONS SUBSYSTEM - The Communications Subsystem, shown in figure 5, prepares and formats data for transmission between the Computer Subsystem and the ATC facilities or other sensors with which the concerned sensor communicates. The Communications Subsystem contains a Communications Tiline and a Communications Interface Tiline. The Communications Tiline interfaces with the Computer Subsystem through two coupler pairs connecting to Global memories A and B respectively. The Communications Tiline contains three computers: a Surveillance computer, a Common ICAO Data Interchange Network (CIDIN) computer and a redundant computer. The Surveillance computer processes surveillance

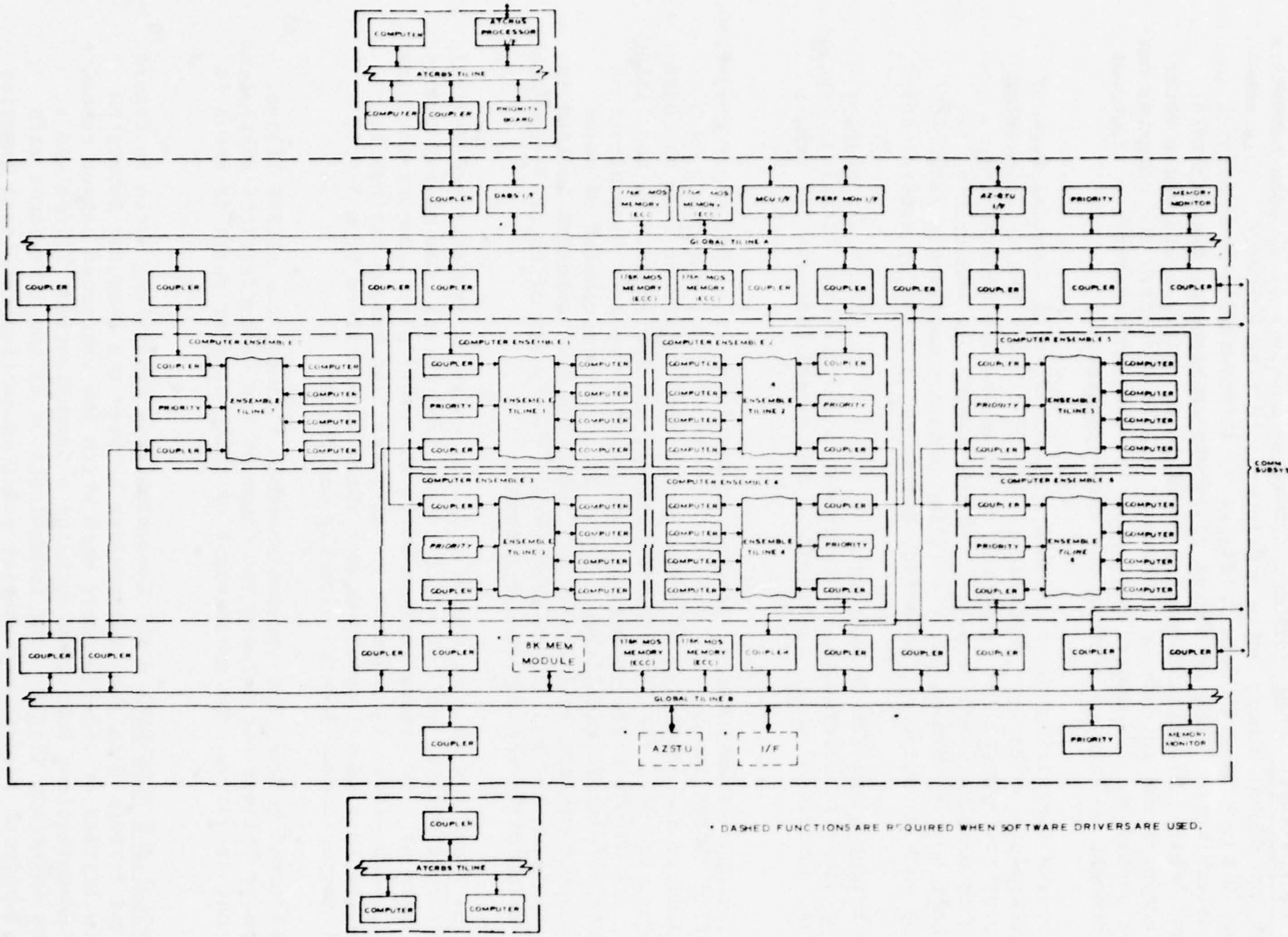


FIGURE 4. COMPUTER SUBSYSTEM BLOCK DIAGRAM

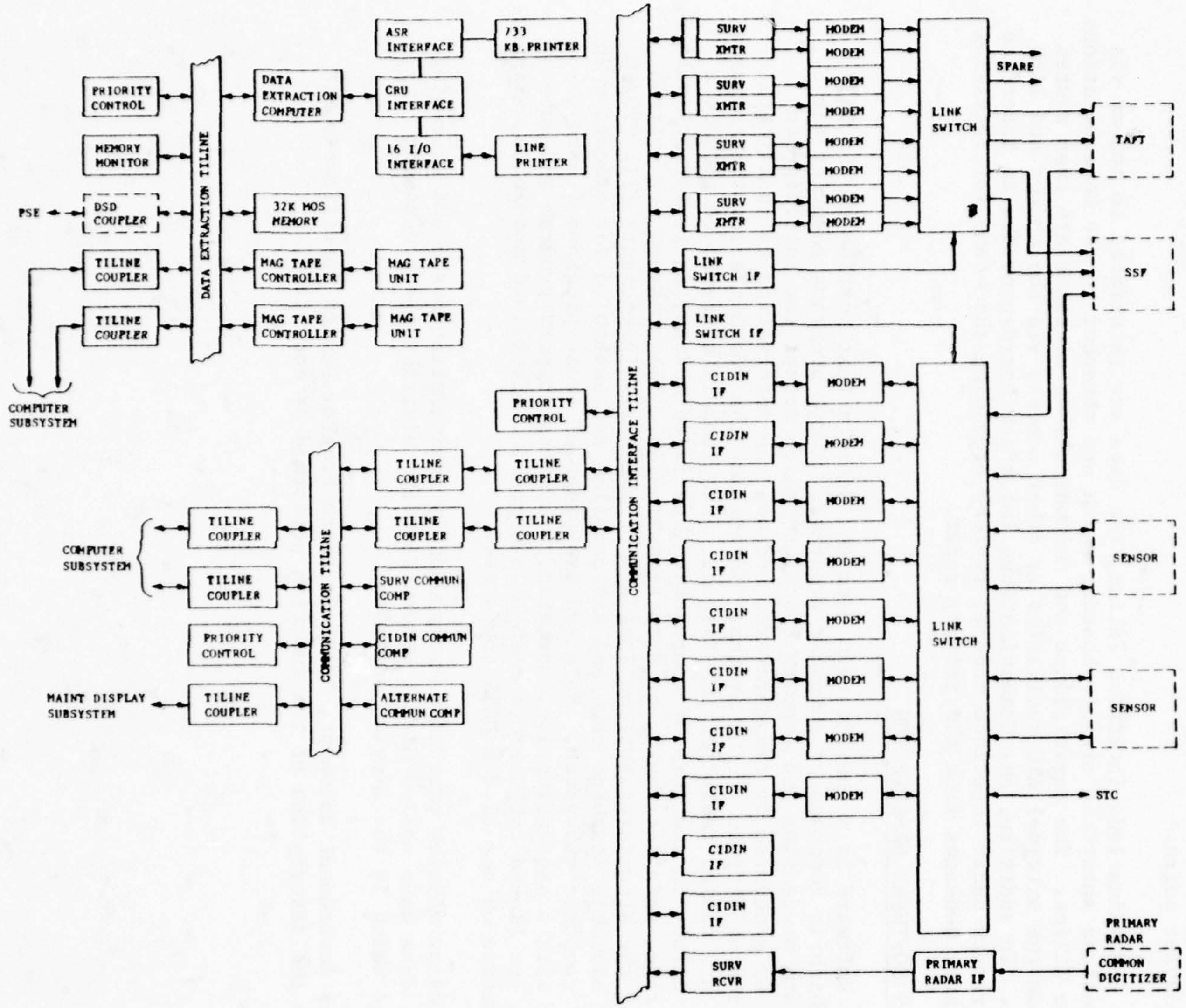


FIGURE 5. COMMUNICATIONS SUBSYSTEM BLOCK DIAGRAM

data from the Computer Subsystem in preparation for subsequent transmission to the ATC facilities or other sensor. The CIDIN computer processes communications messages for transmission in either direction. Data are transferred between the Communications Tiline and the Communications Interface Tiline through either of two coupler pairs.

From the Communications Interface Tiline, the data are interfaced to modems via Communications Interface circuit boards, which are attached to the Communications Interface Tiline. The Surveillance and Communications messages are then routed to or from the external ATC facilities or other sensors via the modems and link switches. In addition, one Communications Interface Board provides an interface to the Primary Radar Interface module, thereby providing the means for receiving surveillance messages from the primary radar.

3.4 DABS SOFTWARE DESCRIPTION

The DABS software is a generic term used to identify that portion of the DABS system which is composed of computer programs. These programs comprise the set of data processing and support functions which accept the intelligence acquired or generated by the hardware, and use the information to facilitate the desired objectives of the system. Throughout the documentation the computer programs are called tasks (or sub-tasks). Each task is designed to produce a specific effect in the form of computation, decision making, equipment activation, data storage, data retrieval, or data transmission. The programs are written in either the structured Fortran language or the Texas Instruments (TI) 990/10 computer assembly language code and are compiled and assembled for execution in the DABS computer subsystem. Selected groupings of these programs (tasks), together with a sequencing logic program, a systems support program and subroutines are linked together to form a load module. Each load module is assigned for execution on one of the DABS computers.

These program modules executing independently and simultaneously and accessing a common data base called Global memory form the distributive processing technique which is the mission software.

The Texas Instrument document, "DABS Software Program Design Specifications," contains the description of the function performed by each task.

4.0 SUBSYSTEM TESTS

The Subsystem Tests will supplement the extensive hardware and software subsystem testing performed by TI during the Factory and Field Acceptance Tests and will be used to fill in any gaps in these areas which are felt to exist. Subsystem tests on the ATCRBS and DABS Processors and on portions of the Receiver will be completed and will be included in the April 1980 TDP. The remaining Subsystem Tests will be considered a secondary effort to be performed on a time-available basis, however, they are described in this document in their entirety for the purpose of completeness.

4.1 INTERROGATOR AND PROCESSOR SUBSYSTEM

The I&P subsystem may be considered as the interface circuitry between the sensor computers and the RF channels. Thus, it consists of equipments which transform digital signals to RF signals and vice versa. Some processing and timing of signals take place in this area, but with the exception of rejecting badly distorted messages, no decisions are made in the I&P subsystem. The levels or parameter values which control the acceptance/rejection rates are manually adjustable. The values for these parameters are to be optimized to produce maximum message acceptance rates with minimum false alarms. To determine the range of values for these parameters and to establish the optimum value is one of the objectives of the proposed tests.

The standard for comparison of system operation is the set of requirements set forth in the ER. The I&P subsystem operation will be checked thru the procedures outlined in the following paragraphs to verify compliance with the basic requirements to determine rate of change of system performance with respect to each system parameter, and to determine the value for each parameter for which the operation of the system is optimal.

4.1.1 ANTENNA

4.1.1.1 TEST OVERVIEW

NAFEC will receive three distinctly different antenna configurations for each of the DABS sites. The NAFEC site will have an ASR-7 radar and four dipoles placed around the horn, i.e., integral beacon feed. The Elwood site will have an ARSR-2 radar and the beacon will consist of two back-to-back open-array antennas. The Clementon site will consist of an ASR-8 radar and an integral beacon feed of eight dipoles. However, shortly following initial installation of the sensors, the antennas at the NAFEC and Clementon sites will be supplemented by open-array antennas. Accordingly, minimal tests, if any, will be conducted using the ASR-7, -8 integral feed modifications.

Each antenna configuration consists of three channels, each of which has a different azimuthal coverage pattern and gain. These channels are: the Sum (Σ) or directional pattern, the Difference (Δ) or antisymmetrical pattern and the Omnidirectional(Ω) pattern.

The antenna tests to be conducted will consist of a theoretical analysis, static or solar tests, and flight tests. Data will be collected with each antenna disconnected from the DABS site in order to define and verify areas of obstruction, reflections, and diffraction unique to the antennas.

4.1.1.2 OBJECTIVES

The objectives of the theoretical antenna analysis are to predict areas of obstruction, diffraction, reflections, differential lobing, vertical lobing, minimum and maximum site parameter level settings for the multichannel receiver, and minimum power levels for the SLS and directional transmitters.

The objectives of the solar tests are to determine the symmetry of the horizontal radar/beacon patterns and location of the radar and beacon vertical pattern peaks.

The objectives of the flight tests will be to verify some aspects of the theoretical data, location of first minimum lobe, cone of silence, to establish the angular coverage of each site, and to verify maximum range requirements.

4.1.1.3 DATA COLLECTION

The theoretical data will be used to predict areas of differential lobing (both ATCRBS and DABS), vertical lobing and min/max angular and range coverage using TI antenna range data and a published computer program (RD 75-31). The basic parameter to be varied in the computer program is the SLS and directional power ratios for various aircraft ranges.

The static tests will be performed using solar data collected on a Hewlett-Packard (HP) desk-top computer. In addition, the Transponder Performance Analyzer (TPA) facility will record signal levels of the Σ, Δ, and Ω antennas, as the antennas rotate, using the mobile beacon van with a transponder. The radar solar data for the vertical beam peak will be collected using a radar receiver calibrated for absolute signal level.

The flight test data to be collected will be a 1090 $\pm$3 MHz signal received in the TPA van and time-lapsed photographic data utilizing a unique code. Four types of flight patterns to be flown are: radials, orbits, cloverleafs, and Z-type patterns. The radial patterns will be flown to characterize signal levels behind buildings, along reflection zones, and over rough, smooth, and watery terrain. The orbital patterns will be flown in zones of low and high detection probability which shall have been identified by the previous theoretical predictions and by radial flights. Orbital patterns will also include flights over a large metropolitan area such as Philadelphia. Cloverleaf patterns will be flown at short ranges and varying altitudes in order to define overhead coverage (and possible monopulse error due to the Elwood dome). A Z-type pattern flight is flown at varying altitudes around the maximum range of

the facility in order to locate the first minimum lobe which will define a minimum angular coverage limit for that site. The Z-type flights will also verify the maximum range limits required. A NAFEC ranging facility will track the aircraft during all flight tests.

For the above tests, the TPA facility, the test transponder, and all cabling and other equipment which will affect the test data must be calibrated.

4.1.1.4 RESULTS AND ANALYSIS

The results of the theoretical analysis will be a general description of the possible environmental effects on an antenna, the major receiver parameters which may improve operation, and the major reply processor site parameter settings required for improved site performance. The analysis of the data will require correlation of site coverage needs versus probability of receiving false targets.

The results of the static tests will be plots of signal level versus vertical angle and off-boresight angle. Analysis of the data will be by examination of the relative radar and beacon beam peaks for pointing accuracy and examination of the horizontal signal level plots for symmetry. The results of the flight tests will be plots of received Σ signal levels versus range for a unique altitude, and PPI time-lapsed photographs of the various types of flights. Analysis of the data will indicate the accuracy of the theoretical data and will indicate the overall performance of the antenna for a DABS configuration.

4.1.1.5 RESOURCES

MATERIAL

Program to merge EAIR and TPA data and plot the results.

HP desk-top computer and X-Y plotter.

Solar Data Receivers.

TPA

Mobile Beacon Van

TI Antenna Patterns

Fortran Program (RD 75-31)

4.1.2 TRANSMITTER

4.1.2.1 TEST OVERVIEW

The purpose of the Transmitter tests is to ascertain the technical characteristics of the Transmitter and the Modulation Control Unit for both the ATCRBS/DABS All-Call and the DABS Roll-Call types of interrogations. While the

Modulation Control Unit is physically part of the Processor, it will be considered functionally as part of the Transmitter for the purpose of these tests. These tests will furnish information on such parameters as frequency stability, peak and average power outputs, pulse characteristics and electromagnetic compatibility. The test results will be subjected to data reduction and analysis which will identify acceptable ranges of operating parameters as well as problem areas.

4.1.2.2 OBJECTIVE

The objective of the transmitter tests is to determine the performance of the transmitter and modulation control unit for both the ATCRBS and DABS modes of operation.

4.1.2.3 DATA COLLECTION

Data collection will be divided into three phases. The first will be the ATCRBS/DABS all-call, the second will be the DABS roll-call, and the third will test the modulation control unit.

1. ATCRBS/DABS All-Call

Data which will indicate the operable range of parameter values, their gray zones (areas of uncertainty) and their stability will be obtained and recorded. In addition, unexpected perturbations and/or characteristics will be noted. Data will be recorded first with the transmitter in the ATCRBS interrogation mode and then with the transmitter in the DABS All-Call interrogation mode. During each of the above interrogation modes, the following parameters will be measured and recorded for both the main and SLS transmitters.

a. The peak and average power will be measured over the range of both the SLS and main transmitters.

b. The following transmitter pulse characteristics will be determined together with their respective operating ranges and gray zones.

1. pulse spacings
2. pulse widths
3. pulse rise and fall timing
4. pulse droop
5. pulse-to-pulse droop
6. transmitter delay and jitter

c. The transmitter frequency stability will be measured and recorded.

d. A special analysis will be performed to determine the radio frequency interference (RFI) spurious emission.

e. Power output differences and/or other unacceptable characteristics between the directional and omni transmitters will be documented.

2. DABS Roll-Call

These tests will determine the performance of the transmitter when in the DABS roll-call interrogation mode. During this phase of the data collection, those portions of the transmitter which are most susceptible to a degradation of performance in the DABS roll-call interrogation mode will be investigated. This will primarily involve tests associated with the directional and omni power as a function of transmitter duty cycle and differential phase shift keying (DPSK) as a peak target environment (400 DABS targets in a 90° sector) is simulated.

a. The transmitter will be operated at maximum power as the number of DABS roll-call interrogations is increased to maximum and the transmitter duty cycle is recorded.

b. The technical performance of the differential phase shift keying will be evaluated. Timing and phase relationships of the RF interrogations will be obtained and recorded.

3. Modulation Control Unit

Data will be obtained which will determine the performance of the modulation control unit. While physically part of the Processor, it will be considered functionally as part of the Transmitter for the purpose of this test. Technical deficiencies relating to the interface uplink coding and parity generation will be noted.

4.1.2.4 RESULTS AND ANALYSIS

Results of the transmitter tests will include plots of power output as a function of the various transmitter parameters. Results will also indicate the following:

1. Waveform fidelity
2. Frequency stability
3. Pulse characteristics as a function of output power
4. Electromagnetic Compatibility
5. Power output and/or any other differential deficiences between the directional and omni transmitters
6. DPSK performance characteristics for DABS roll-call interrogations

Data reduction and analysis will detail unacceptable transmitter characteristics, identify potential problem areas, and note how results of other DABS tests could be affected as a function of the transmitter characteristics.

4.1.2.5 RESOURCES

MATERIAL

RF Loads and Power Meters

Memory-Scope

Frequency Meters

Spectrum Analyzer

ARIES

4.1.3 RECEIVER

4.1.3.1 TEST OVERVIEW

The multichannel receiver processes RF signals which are inputted to the system from the DABS sensor antenna. The multichannel receiver outputs video and quantized (two-level) video signals to the DABS and the ATCRBS reply processors. Quantized two-level signals ($Q\Sigma A$, $Q\Sigma D$, QSLSA, and QSLSD) outputted by the receiver indicate whether the signal was in the main beam or a sidelobe and whether it might be a DABS (D) or ATCRBS (A) signal.

Quantized levels $Q\Sigma PS$ and $Q\Sigma NS$ indicate if the pulse slope level was exceeded. In addition, the receiver outputs an analog signal approximating the complex ratio $\hat{\Delta}/\hat{\Sigma}$. The receiver uses twelve site-dependent adjustable levels in order to: (a) reduce low-level multipath (K_D, τ_D, K_A, τ_A), (b) reduce close-in false targets (T_{stcd}, T_{stca}) due to reflections, and (c) reduce the likelihood of detecting noise (T_{fa}, T_{fd}). There is also a level ($T\Omega$) which functions as amplitude-received sidelobe suppression and a level ($T\Delta$) used in conjunction with $T\Omega$ to eliminate the detection of pulses outside the main beam.

The purpose of the tests is to verify overall functional requirements of the receiver using extreme and intermediate perturbations at down-link frequencies and to determine what level of multipath can be eliminated through the use of site-adjustable parameters. The overall functional requirements of the receiver to be verified are pulse detection, two-pulse resolution, sidelobe discrimination, low-level multipath reduction, and monopulse estimation. An analytical examination of the TI antenna data will be used to predict minimum and maximum site parameter levels of T_{stca}, T_{stcd}, $T\Omega$ and $T\Delta$.

4.1.3.2 OBJECTIVES

The objective of the pulse detection test is to statistically determine the operating range of the quantized receiver outputs and the effect some of the site parameters have on pulse detection capability. The objective of the two-pulse resolution test is to determine the level of performance of the receiver over a range of input overlapping pulses.

The objective of the sidelobe discrimination test is to determine the level of performance of the receiver over a range of mainbeam/sidelobe ratio levels.

The objective of the low-level multipath test is to determine if a loss of valid target replies could occur due to a maximum utilization of the parameters K_A, τ_A, K_D, and τ_D.

The objective of the monopulse estimation test is to determine the operating range of the monotonic function approximated by $\hat{G}\Delta / \hat{G}\Sigma$.

4.1.3.3 DATA COLLECTION

The pulse detection test will input a standard rf pulse at a variable amplitude and frequency and measure the number of quantized counts that occur at the $Q\Sigma A$, $Q\Sigma D$, $Q\Sigma PS$, $Q\Sigma NS$, QSLSD, and QSLSA output ports. Secondly, the input will be set to 1087, 1090, and 1093 MHz, and -79, -50, and -20 dBm (i.e., at extreme and intermediate frequency and amplitude levels), then each of the following site parameters (T_{stca}, T_{stcd}, T_{fd}, T_{fa}, T_{ps}, T_{ns}, $T\Omega$, and $T\Delta$) will be varied over its operating range and the number of quantized counts occurring at each of the VPQ output ports will be measured. Variation of each parameter independently requires that all others be placed in their "off" position or at a level that will have minimum effect on the output. The STC curve, (i.e., T_{stca}, T_{stcd}), can be varied by adjusting a single point (C_{stca}, C_{stcd}).

The two-pulse resolution tests will be performed by injecting two overlapping pulses at 1087, 1090, and 1093 MHz and -79, -50, -20 dBm and +18, -18 dB, then varying their separation from concurrent positions to a maximum separation. Each of the two pulses will initially have the same level and subsequently have a subset of the possible permutations of the above levels.

The sidelobe discrimination test will be performed by varying an input rf omni signal over a +6 dB to -20 dB range, relative to the sum signal at three extreme and intermediate frequency and amplitude levels. (Any variation in the site parameters to $T\Omega$, $T\Delta$, T_{FD}, and T_{FA} will require this test to be rerun. Also the analysis of the DABS antenna range data will dictate the minimum and maximum settings of $T\Omega$ and $T\Delta$ in order to conform to either DABS or ATCRBS coverage requirements). The $Q\Sigma A$, $Q\Sigma D$, QSLSA, and QSLSD outputs will be measured with a counter.

The low-level multipath reduction test will be performed at two levels using the TTG as an overlapping rf pulse input source. The TTG will input two pulses at 1090 MHz and -50 dBm over a relative range of $\pm$18 dB and 0 to +1.5 μs separation. The parameters K_D, τ_D, K_A, τ_A will be varied and the outputs $Q\Sigma D$ and $Q\Sigma A$ observed for any possible degradation. The parameters K_D, τ_D, K_A, τ_A will be varied and the output recorded on magnetic tape.

4.1.3.4 RESULTS AND ANALYSIS

The results of the pulse detection test will consist of plots of percentage of possible occurrences versus a varying rf pulse amplitude for a set of selected input frequencies for the multichannel receiver. Secondly, plots of percentage of possible occurrences versus each of the site parameter levels for a set of rf input amplitude and frequency levels will be produced. Analysis of the data requires examination of the slopes, asymptotic levels, site parameter effects of quantized outputs, and implicit differential experimental equations relating site parameter levels to quantized outputs for unique input frequency and amplitude levels.

The results of the two-pulse detection tests will be plots of percentage pulse detection versus two-pulse separation times for unique rf input frequencies, amplitudes, and relative amplitude levels. Analysis of the data will require correlation of the data with the pulse detection data for possible effects of some site parameter setting such as T_{ps} and T_{ns}. The results of the sidelobe discrimination tests will be plots of percentage of possible counts of QSLSA/Q Σ A and QSLSD/Q Σ D for a variable Ω/Δ ratio input over a unique set of Σ amplitude and frequency levels. Analysis of the data will require examination of the slopes and asymptotic levels and correlation with the pulse detection tests for site parameter effects.

The results of the low-level multipath tests will be plots of number of true and false pulses versus low-level multipath parameters K_d, τ_d, K_a, and τ_a. Analysis of the data will indicate the range of the site parameter levels which might have an effect on overall DABS performance.

The results of the monopulse estimator test will be plots of $\hat{G}\Delta/\hat{G}\Sigma$ versus off-boresight angle for unique frequency and amplitude settings. Analysis of the data will require observations to determine if the multichannel receiver operates within specifications and the possible effects of terrain using a unique CPME for calibration.

4.1.3.5 RESOURCES

MATERIAL

Narrow-Band Filters

Modulators

Counter

Memory-Scope

Network Analyzer

Couplers

TTG modified for rf

ARIES

4.1.4 DABS REPLY PROCESSOR

4.1.4.1 TEST OVERVIEW

These tests are designed to determine the performance of the critical elements which comprise the DABS Reply Processor. These elements are: video digitization, message bit and monopulse processing, and error detection and correction.

Three functions of the video digitization element will be tested. These are: (1) lead and trail edge detection, which will be tested by inserting rf test pulses which are variable in time and amplitude; (2) preamble detection, which will be tested using a CPME to generate DABS replies; and (3) monopulse analog-to-digital converter calibration, which will be tested using a square-wave generator.

The message bit and monopulse processing element will be tested using 56- and 112-bit messages generated by a CPME and/or an ARIES. The error detection and correction element will be tested using the same test configuration.

4.1.4.2 OBJECTIVE

To define the performance of the critical elements which make up the DABS Reply Processor.

4.1.4.3 DATA COLLECTION

The following paragraphs detail the data necessary to define the performance characteristics of the DABS Reply Processor functions.

1. Video Digitizer - There are three major elements that comprise the digitizer function.

a. Lead and Trail Edge Detection - The performance of this function will be determined by injecting the controlled radio frequency (rf) test pulses that will be varied in time and amplitude. One of the two pulses will be stationary in position and the rf level will be established at a level equal to 3 dB above minimum useable signal level (MUSL). The second pulse will be positioned at approximately 300 nanoseconds (nsec) prior to the position of the fixed pulse. Its level will be adjusted to a level equal to the stationary pulse. It will then be moved in 10-nsec steps in an increasing direction of time to the point at which its position is approximately 300 nsec later than the fixed pulse. This procedure will be repeated for differing rf levels ranging up to 18 dB in 1-dB steps. For each of the pulse positions and amplitude differences, the occurrence of leading and trailing edges and their position relative to the actual pulse position will be recorded. This includes any potential trail edge indications.

b. Preamble Detection - The CPME will be employed to generate DABS replies with rf levels ranging from MUSL to one that results in 100-percent detection of the preamble. Various levels of interference will be introduced to determine the best value of parameter K (the number of successive samples of each preamble pulse required to declare the pulse as valid). The desired levels of rf signal will be obtained by inserting an rf variable attenuator into the receiver and adjusting it for the appropriate levels.

c. Monopulse Analog-to-Digital Converter Calibration - The 8-bit count of the monopulse analog-to-digital converter will be recorded as a function of the level of a test square-wave test signal. The level will be varied over the full range of the capability of the converter.

2. Message Bit and Monopulse Processing - Test inputs to the DABS Sensor derived from the CPME and/or the ARIES will be employed to obtain confidence and decision bit data along with the Monopulse Acceptability indicator for various rf levels and interference. Additionally, the corresponding monopulse value for each reply will be recorded as the monopulse difference parameter "K" is varied over its defined range of 0 to 63. Message lengths of 56 and 112 bits will be employed for each tested rf and interference level.

3. Error Detection and Correction - The test configuration defined in the previous paragraph will be employed to record data defining the performance of the error correction function. Specifically, the expected address and message content will be recorded along with the decoded address and message. These data will be associated with the successful decode indication bit "m" and the status of the correction disable bit. The tests will be conducted for various values of the test confidence circuitry parameter "K" which determines the status of the correction disable bit. The rf levels of the DABS test replies and interference signal will be varied over a range of values that will provide sufficient data to define the performance of the functions in question.

4.1.4.4 RESULTS AND ANALYSIS

The required relationships of data necessary to clearly define DABS Processor performance are delineated below:

1. Pulse Positional Accuracy as a function of:

a. The 50% amplitude of a pulse

b. Interference pulses

2. Declaration of Trail Edge as a function of:

a. Input pulse/pulses

b. Occurrences of trail edge with no potential edge flagged

c. Number of potential trail edge flags associated with the number that are confirmed and reset.

3. Preamble Detection as a function of:

a. RF Level

b. Interference rate

c. Parameter K establishing the number of successive samples of each preamble pulse required to declare the pulse as valid.

4. Monpulse Analog-to-Digital Converter Calibration - A curve will be presented indicating the transfer function of the converter relative to the monopulse number that corresponds to each input level.

5. Message Bit Processing

a. Distribution of decision bit, confidence bit, quantized SLS, and monopulse number as a function of rf level and parameter K.

b. Frequency of occurrence of not establishing a monopulse number as a function of variables.

c. Establish value of K for monopulse difference.

6. Error Detection and Correction

a. Percent correlation of flagged error messages and true errors existing.

b. Percent occurrence of flagged error with no actual error.

c. Percent occurrence of message error with no error flagged.

d. Correlation between error in address and incorrect information in remaining message bits.

e. Correlation between error in address and correct information in remaining message bits.

f. Percent occurrence of a successful message correction.

g. Frequency of setting correction disable bit.

h. Establish best value of parameter K of the confidence test circuitry.

4.1.4.5 - <u>RESOURCES</u>

<u>MATERIAL</u>

Test Target Generator

Square-Wave Generator

CPME

Data Extraction and reduction programs

PERSONNEL

Two Engineers

One Technician

One Programmer

One System Analyst (part-time)

4.1.5 ATCRBS REPLY PROCESSOR

4.1.5.1 TEST OVERVIEW

These tests are designed to identify the static performance of the ATCRBS Reply Processor. Identification of the characteristics of the variable parameters of this unit is the main purpose of these tests. The identification of the performance of the various elements of the ATCRBS Processor will be obtained as a function of the variable parameters. Optimization of each variable parameter will result from this set of tests.

The system test target generator will be the source of target information for these tests.

4.1.5.2 OBJECTIVE

To determine the performance of the Lead and Trail Edge Estimators, Bracket Detection, Reply Processing and Garble Recognition functions of the ATCRBS Processor.

4.1.5.3 DATA COLLECTION

The data necessary to define the performance characteristics of the ATCRBS Processor will be obtained for each of the subfunctions delineated under the aforementioned objective.

1. Lead and Trail Edge Estimators - The performance of this function will be defined for two categories of tests. The first will consist of obtaining the number of declared leading and trailing edges, including potential trail edges and pseudo leading edges, as a function of controlled pulse width, pulse rise and decay times. The second phase will involve collection of similar data for overlapping and closely spaced pulses with varying amplitude differences. The above tests will be conducted for values of δ_L and δ_T ranging between 100 and 400 nsec.

2. Bracket Detection - The CPME's will be employed to provide test replies with various rf levels as referenced to the Minimum Usable Signal Level (MUSL). Attenuators will be employed to establish the necessary levels between MUSL and that necessary to achieve 100-percent bracket detection. The number of bracket detections per target will be recorded as a function of rf level and will be related to the number of replies generated by the test CPME's.

3. Reply Processing - These tests will be divided into two major categories:

a. Reply Pulse Position - A single reply each sweep at a specific range will be generated with a single code pulse. This code pulse will be varied from its nominal position by plus and minus 200 nsec in 50-nsec steps. The number of pulses detected at each position will be recorded.

b. Garble Recognition and Confidence Bit Assignment - This test is designed to determine the occurrence of garbled replies and the status of the confidence bits associated with each reply in a situation of two overlapped reply trains. The confidence bits rely on the examination of the monopulse value of each pulse. Therefore, two targets having different discrete codes will be placed such that the start azimuth of one is to the left of the start azimuth of the other. More specifically, the start azimuth of the second should occur at the midpoint of the run-length of the first target. The targets will be separated in range such that the F_1-to-F_1 spacing will be approximately 30 usec. The point of observation will be at an azimuth that is common to both targets and established such that target one will appear to the left of boresight and target two to the right of boresight.

The F_1-to-F_1 spacing will be reduced in 50-nsec steps until the two replies become completely overlapped. The number of replies reported, the codes and confidence bit status will be recorded for each separation. This test will be repeated for several other azimuth relationships, for example, both being to the left or right of boresight. Fruit interference will be introduced at levels that vary between 0 and 20K per second. Critical system adaptation parameters that must be optimized during this test phase are: (1) parameter "K," which is the maximum difference between the average monopulse value and the monopulse number for the reply being processed; (2) parameters MBL and MBH, which establish the limits of what is to be considered as a main beam reply; and (3) the method of bracket detection, i.e., the option that the bracket detection does not have to occur in the main beam.

4.1.5.4 RESULTS AND ANALYSIS

The data collected in the preceding paragraph should be employed to develop the following relationships:

1. Percent Bracket Detection as a function of rf signal level.

2. Accuracy of lead and trail edge position as compared to expected position.

3. Reply pulse detection as a function of position.

4. Code Validity versus decision and confidence bit indicators for each reply related to range and azimuth separation. These results will be presented as a function of the number of confidence bits and the condition of the declared code, i.e., true or false.

4.1.5.5 RESOURCES

MATERIAL

Test Target Generator with RF Interface

PERSONNEL

Two Engineers
One Technician
One Programmer
One Part Time Analyst

4.1.5.6 PREREQUISITES

1. RF interfaces for TTG available

2. Receiver performance tests completed

3. DABS Mission software modified to provide recording of reply data with system data extractor when employing the TTG as a signal source.

4.2 INTERFACES

4.2.1 GENERAL

Tests will be conducted on the hardware elements which comprise the digital interfaces to the DABS sensor to ensure proper operation.

The emphasis during these tests will be on an evaluation of the compatibility between the hardware being provided with the DABS sensor and the existing hardware at NAFEC with which it interfaces.

These tests will include the Telco lines, Modems, Communications Multiplexer Controller, Surveillance links to the ATC Facilities, CIDIN link to the TATF, and Primary Radar Interface.

Tests of the protocol between the sensors and the ATC Facilities will be conducted during the Communication System tests. (See section 6.7)

4.2.2 TELCO LINES

4.2.2.1 TEST OVERVIEW

These tests will be conducted prior to the delivery of the sensors. They will be conducted on the Telco lines installed by New Jersey Bell Telephone Company for DABS intersite data transmission. Measurements will be made for envelope delay, line attenuation, and frequency translation.

4.2.2.2 OBJECTIVES

The objective of these tests will be to gather baseline data upon the Telco lines being used for DABS. Additionally, comparisons will be made of these data with the specifications for unconditioned lines.

4.2.2.3 DATA COLLECTION

Halcyon Model 515A Data Line Test Sets will be used to collect data on envelope delay, line attenuation, and frequency translations. Measurements will be made in both directions for each installed Telco line. Additional measurements will be made to the System Test Console (STC) drop for those lines with the multipoint drop for data monitoring at the STC.

4.2.2.4 RESULTS AND ANALYSIS

Plots will be prepared for all Telco lines to show the line characteristics. Plots will be prepared for envelope delay (relative delay vs. frequency), frequency response (attenuation vs. frequency), and frequency translation (error in received frequency vs. frequency transmitted). These plots will be saved as a baseline data base for the installed lines, and for comparison with similar measurements made throughout the T&E effort.

Additionally, the plots will be compared against the specifications for the lines as stated in FCC tariff 260.

4.2.2.5 RESOURCES

MATERIAL

Two Halcyon Data Line Test Sets Model 515A

PERSONNEL

Two Engineers

4.2.2.6 PREREQUISITIES

Prior to the start of these tests, the installation and checkout of the Telco lines must be completed by the New Jersey Bell Telephone Company.

4.2.3 MODEMS

4.2.3.1 TEST OVERVIEW

The performance of the Codex LSI 48I modems being supplied with the DABS sensor will be evaluated in the NAFEC environment. Known data patterns will be transmitted over each modem link and compared to the received patterns. For those links with monitoring drops for the STC, the data patterns will also be received and compared at the STC drop.

All of the possible combinations of operating modes for the modems will be tested.

4.2.3.2 OBJECTIVES

The objective of these tests is to evaluate the functional operation of the Codex modem when used in the NAFEC environment with the locally provided unconditioned Telco lines. An additional objective is to determine the optimum operating modes for the Codex modems when used in the NAFEC environment.

4.2.3.3 DATA COLLECTION

Tele-Dynamics Model 7914 Data Set Testers will be used to transmit, receive, and compare the data patterns. The data patterns shall include all zeroes, all ones, alternate ones and zeroes, and a pseudo-random pattern.

The data sets will be operated over periods of several hours for each combination of data pattern and operating mode. At the completion of each test run, the number of bit errors detected by the data set tester will be recorded along with the length of the test.

4.2.3.4 RESULTS AND ANALYSIS

The data collected on bit error rates will be compared for each of the operating modes. Based on these comparisons, recommendations will be made as to the optimum operating mode for the modems during the DABS T&E effort at NAFEC.

4.2.3.5 RESOURCES

MATERIAL

Four Tele-Dynamics Model 7914 Data Set Testers
DABS Communication Subsystem Modems

PERSONNEL

Two Engineers

4.2.3.6 PREREQUISITES

Prior to the start of these tests, the Telco line tests must be completed and the sensor modem installation and checkout completed.

4.2.4 COMMUNICATION MULTIPLEXER CONTROLLER

4.2.4.1 TEST OVERVIEW

These tests will be conducted following the installation and checkout of the Communication Multiplexer Controller (CMC) in the TATF at NAFEC.

The Radar Receiver Adapter (RRA), Communications Transmitter Adapter (CTA) and Communications Receiver Adapter (CRA) which will be used with the DABS sensor will be tested.

4.2.4.1.1 RADAR RECEIVER ADAPTER

Simulated surveillance messages will be generated by the Air Traffic Control Simulation Facility (ATCSF) utilizing the special ATCSF/DABS Test Software package. These messages will be transmitted to the two RRA's in the CMC. The received messages will be evaluated by the TATF/DABS Test Software package.

4.2.4.1.2 COMMUNICATIONS ADAPTERS

The preliminary testing of the CTA and CRA adapters used for the CIDIN communication link will be by loop-back, due to the non-availability of a source for CIDIN-formatted messages. The output of the CTA will be connected to the input of the CRA. Messages transmitted by the CTA will be received by the CRA. The messages received will be compared to those transmitted. Additionally, a logic analyzer will be connected to monitor the connection between the CTA and CRA. Upon availability of the ATCSF Interface, some of the tests on the Communications Adapters will be repeated in order to provide checkout of the ATCSF Interface.

4.1.2.4.2 OBJECTIVE

The objective of these tests is to demonstrate that the adapters contained in the CMC are compatible with the equipment being provided with the DABS sensor.

4.2.4.3 DATA COLLECTION

Any discrepancies determined by the test software will be printed for analysis. Additionally, any anomalies noted with the logic analyzer will be recorded.

4.2.4.4 RESULTS AND ANALYSIS

The data collected will be analyzed to determine if any major compatibility problems exist between the CMC and its adapters and the DABS sensor hardware.

4.2.4.5 RESOURCES

MATERIAL

Communication Multiplexer Controller including:

- 2 Radar Receiver Adapters
- 1 Communications Transmitter Adapter
- 1 Communications Receiver Adapter

CIDIN Test Driver Software for TATF

ATCSF

ATCSF DABS Test Software

TATF DABS Test Software

One Logic Analyzer

PERSONNEL

Two Engineers

4.2.4.6 PREREQUISITES

Prior to the start of these tests, the CMC with its adapters must be installed and checked out on the TATF at NAFEC.

4.2.5 SURVEILLANCE LINKS TO ATC FACILITIES

4.2.5.1 TEST OVERVIEW

During these tests, known surveillance messages will be generated by a test driver program in the DABS sensor. These messages will be transmitted through the surveillance interface boards and modem link to the Data Receiver Equipment (DRE) in the SSF and to the RRA in the TATF. The Enroute and Terminal Interface Verification Software packages will be used to evaluate and record the messages received.

4.2.5.2 OBJECTIVES

The objective of these tests is to demonstrate the compatibility of the DABS sensor hardware with the DRE and RRA for surveillance data.

4.2.5.3 DATA COLLECTION

The messages transmitted from the DABS sensor will be recorded. The messages received by the Interface Verification software will be recorded. Additionally, the Interface Verification software will give an on-line indication of the quality of the surveillance data received during the test.

4.2.5.4 RESULTS AND ANALYSIS

The data received will be compared to that transmitted and any discrepancies noted. The data will be analyzed to determine if any compatibility problems exist.

4.2.5.5 RESOURCES

MATERIAL

Test Driver Software for Sensor

Enroute Interface Verification Software

Terminal Interface Verification Software

Data Receiver Equipment

9020 Simplex

CMC with 2 RRA's

ARTS III Computer

DABS Communication Subsystem

PERSONNEL

Two Engineers

4.2.5.6 PREREQUISITES - None

4.2.6 CIDIN LINKS TO TATF

4.2.6.1 TEST OVERVIEW

During these tests, known CIDIN messages will be generated by a test driver in the DABS Sensors. These messages will be transmitted through the CIDIN Transmit Interface board and modem link to the CRA on the TATF. Likewise, messages will be transmitted from the TATF through the CTA to the CIDIN Receive Interface board.

4.2.6.2 OBJECTIVE

The objective of these tests will be to demonstrate the compatibility of the CTA and CRA with the CIDIN interface boards.

4.2.6.3 DATA COLLECTION

The messages transmitted over the links will be recorded at both ends. In addition, any error conditions detected by the hardware will be noted.

4.2.6.4 RESULTS AND ANALYSIS

The transmitted and received messages will be compared. The data will be analyzed to determine if any compatibility problems exist.

4.2.6.5 RESOURCES

MATERIAL

Test Driver Software for DABS Sensor

Terminal Interface Verification Software

CMC with CTA and CRA

ARTS III Computer

DABS Communication Subsystem

PERSONNEL

Two Engineers

4.2.6.6 PREREQUISITES - None

4.2.7 PRIMARY RADAR INTERFACE

4.2.7.1 TEST OVERVIEW

During these tests, known radar surveillance messages will be provided to the Primary Radar Interface. These data will be transmitted across the interface to the surveillance receive interface board and inspected by test driver software. All valid message types will be transmitted. Tests will be conducted over the range of data transfer rates from 2,400 bits per second to 35,000 bits per second.

4.2.7.2 OBJECTIVES

The objective of these tests is to evaluate the compatibility of the Primary Radar Interface with the Radar Digitizers which may be used with DABS.

4.2.7.3 DATA COLLECTION

The surveillance messages will be provided by a test set with an interface in accordance with MIL-STD 188C and capable of accepting a clock signal in excess of 35,000 bits per second. The test driver software will be capable of comparing the data received to the data expected, and reporting any detected errors.

4.2.7.4 RESULTS AND ANALYSIS

The messages received will be compared to those transmitted. The data will be analyzed to determine if any compatibility problems exist.

4.2.7.5 RESOURCES

MATERIAL

Test Driver Software for DABS Sensor

Surveillance Message Test Set

DABS Communication Subsystem

PERSONNEL

Two Engineers

4.2.7.6 PREREQUISITES - None

4.3 DATA EXTRACTION

4.3.1 TEST OVERVIEW

The Data Extraction Subsystem contains four functions:

1. Data collection - extracts and records data on tape in real time from the operating system.

2. Quick Look - provides timely listings of selected portions of recorded data via the 990/10 Program Support Equipment (PSE).

3. Playback - inputs previously recorded reply data to simulate the front end of the sensor.

4. Extended Analysis - provides an indepth analysis (listings, plots, statistics, etc.) of system performance. Operates on IBM 360 computer.

Because the entire NAFEC T&E effort is greatly dependent on the ability to extract and analyze data from the sensor, it is essential that this subsystem be tested promptly and any deficiencies be identified and corrected. The performance of the data extraction subsystem will, moreover, be closely monitored throughout the test effort at NAFEC.

4.3.2 OBJECTIVES

The purpose of the test is to characterize the performance of the four functions of the data extraction subsystem. It shall be determined whether the extractor:

1. Meets the requirements as specified in ER-240-26.

2. Functions according to TI design.

3. Is a useful and practicable tool in performing the NAFEC T&E.

4.3.3 DATA COLLECTION

1. Data collection function - The principal source of test inputs will be from the ARIES system. Various scenarios, representative of those to be used in subsequent testing, will be run. Parameters to be varied include aircraft volume, fruit rate and mixture of target types (DABS, ATCRBS, and radar). For a given scenario, various combinations of data categories will be selected for extraction and priorities assigned. The contents of the extractor tape will be examined via quick look (PSE) and formatted data displays on the IBM 360.

2. Quick look function - Data in the form of lists, summaries, counts, etc. shall be selected from representative extractor tapes by time, scan number, track number, DABS ID, ATCRBS ID, altitude, range, azimuth, and any other appropriate delimiters.

3. Playback function - Several scenarios, increasing in target density and distribution, will be used to determine the maximum playback capability. For a given scenario, ATCRBS and DABS reply data from a playback tape will be reinserted into the system. Resulting position data (target reports, surveillance file, etc.), will be extracted and compared with corresponding data from the original extractor tape.

4. Extended analysis function - From representative extractor tapes, and using various prefilters, the subfunctions of extended analysis will be exercised. The formatted data display capability shall use the same extractor tapes and delimiters as quick look to provide a direct comparison of the printouts obtained from each reduction program.

4.3.4 RESULTS AND ANALYSIS

1. Data collection function - The limitations of the extraction process shall be determined so that subsequent scenarios can be planned in the most efficient manner. Specifically, the following will be ascertained.

a. Whether the extraction process encumbers sensor capability.

b. The amount of data to expect from a given scenario.

c. Whether the tape drives on the data extraction computer switch successfully, without loss of data, when a tape is full.

d. Whether the priority scheme functions properly.

e. Under what sensor load various volatile data (e.g., reply data) are lost.

2. Quick look function - It will be determined whether:

a. The input scheme is practical and functional.

b. The output formats are readable and readily interpreted.

c. The results are consistent with those obtained from extended analysis.

3. Playback function - Extractor tapes obtained from the original run and from the playback mode will be dumped via quick look and their contents compared. A level of confidence for playback will be determined.

4. Extended analysis function - Outputs will be compared to corresponding T.I. IBM 370 outputs to verify computer compatibility. Printouts from the formatted data display capability will be compared to those from quick look. Outputs of all extended analysis subfunctions will be examined for proper functioning and clarity of format. CalComp plots will be compared against ARIES scenarios plots.

4.3.5 RESOURCES

MATERIAL

ARIES

TI 990/10 PSE

IBM 360 (9020) Computer

CalComp Plotter

4.3.6 PREREQUISITES

TI Factory and Field Acceptance Tests.

4.4 AVIONICS

Evaluation of the avionics subsystem is not an objective of the DABS T&E program. However, to assure reliable test data on the DABS sensor, it is essential that the avionics be evaluated before starting the DABS flight tests. With the aid of the transponder test set (being designed and built by NAFEC) a thorough check of the DABS transponder shall be accomplished. In addition to the checks of the rf section, a series of prerecorded messages in the various interrogation modes shall exercise the transponder circuitry. The tester shall be designed and configured to facilitate transponder evaluation on the flight line so as to assure that this vital link is functioning in accordance with the DABS National Standard prior to committing expensive flight time. In addition, any available displays or extended length message devices shall undergo testing so as to assure that the avionics subsystem is functional at a level commensurate with the DABS.

4.4.1 TRANSPONDER TEST SET

The transponder test set (TTS) is being designed and fabricated at NAFEC and shall be used extensively during the DABS T&E program to assure that the transponder is operating at a level commensurate with the DABS. In addition, the TTS shall be invaluable during the check out of the Type A and Type B transponders being purchased for future implementation.

The TTS shall consist functionally of three separate units which are defined as:

1. RF interrogator/receiver unit
2. Flight line unit
3. Bench test unit

The rf interrogator/receiver unit is used either with the bench test unit for performing bench tests or with the flight test unit for performing flight tests.

The bench tests are those tests to which new transponders and those transponders for which the operation is in doubt will be subjected. They will be intensive and extensive in nature. The flight line tests are a minimum group of tests to which a transponder which has already undergone bench tests can be subjected. These tests are designed to be carried out with the transponder already installed in the aircraft.

The rf and flight line units shall be configured as indicated in figure 6 for preflight checks of the DABS transponder while it is mounted in the aircraft. The automatic sequence of preflight checks shall consist of the following measurements:

1. Transponder sensitivity
2. Transponder power output level
3. P1/P2 and P1/P5 suppression ratios
4. DABS message cycle
5. Mode 3/A and Mode C decoding

These measurements will be performed in a serial manner with the results of each test displayed on a front panel indicator. The transponder sensitivity, power output, and suppression ratios will be displayed in dB. The DABS message cycle test will be accomplished by initiating a stored sequence of DABS interrogations. Each of the different DABS interrogation types will be transmitted and the reply from each interrogation will be verified. In the synchronous surveillance and comm-A modes, the EPOCH, CP and CB fields will be checked for the correct cycling of information. The address will be verified for each DABS reply. A "GO" or "NO GO" indication will be presented at the end of the DABS cycle test and also at the end of the mode 3/A and mode C decoding test.

The flight line unit may also be operated in a manual mode. In this mode any ATCRBS or DABS interrogation may be generated at a PRF of 50, 400, or 1,000 Hz. In addition, a single interrogation or an external source may be used to drive the interrogator. When used in the manual mode, any 24-bit address may be switch-selected on the test set front panel. The data field will contain either 56 or 112 bits.

Transponder tests on the bench shall use the rf unit and the bench test unit as shown in figure 7. The bench test unit shall consist of an LSI-11 microcomputer, dual floppy disks, a VT-55 graphics display with hard copy unit, and a hardware interface box. Use of the LSI-11 microcomputer provides the capacity and flexibility to perform detailed transponder testing. The VT-55 will be used to display the results of automatic testing. Two types of bench tests shall be run. The first shall be detailed parameter checking of new transponders and will consist of an automatically executed series of tests that shall characterize transponder performance. The parameters checked are:

1. Transponder sensitivity
2. Transponder output power
3. Transponder frequency
4. Modes 3/A and C decoding accuracy

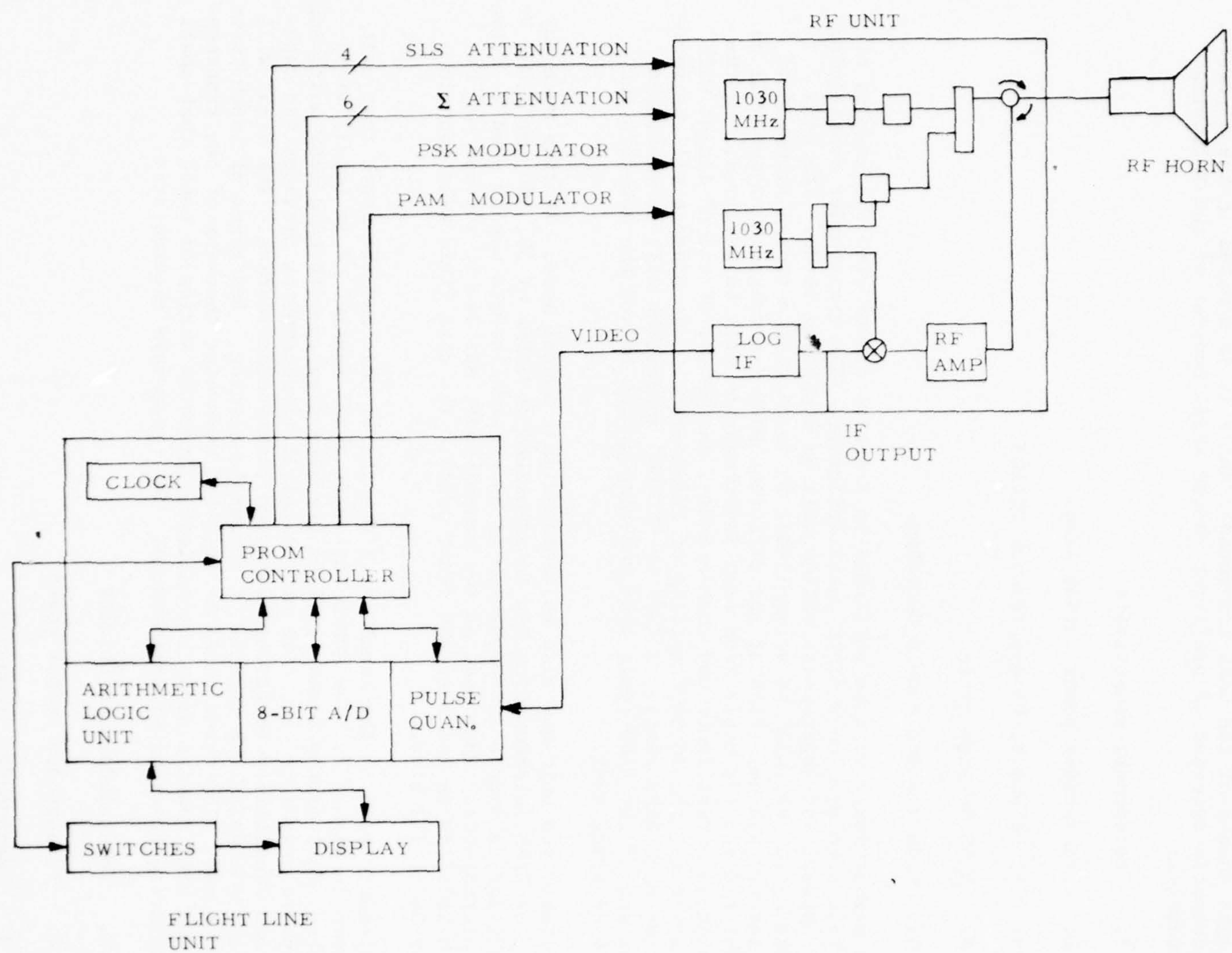


FIGURE 6. TRANSPONDER TEST SET - FLIGHT TEST CONFIGURATION

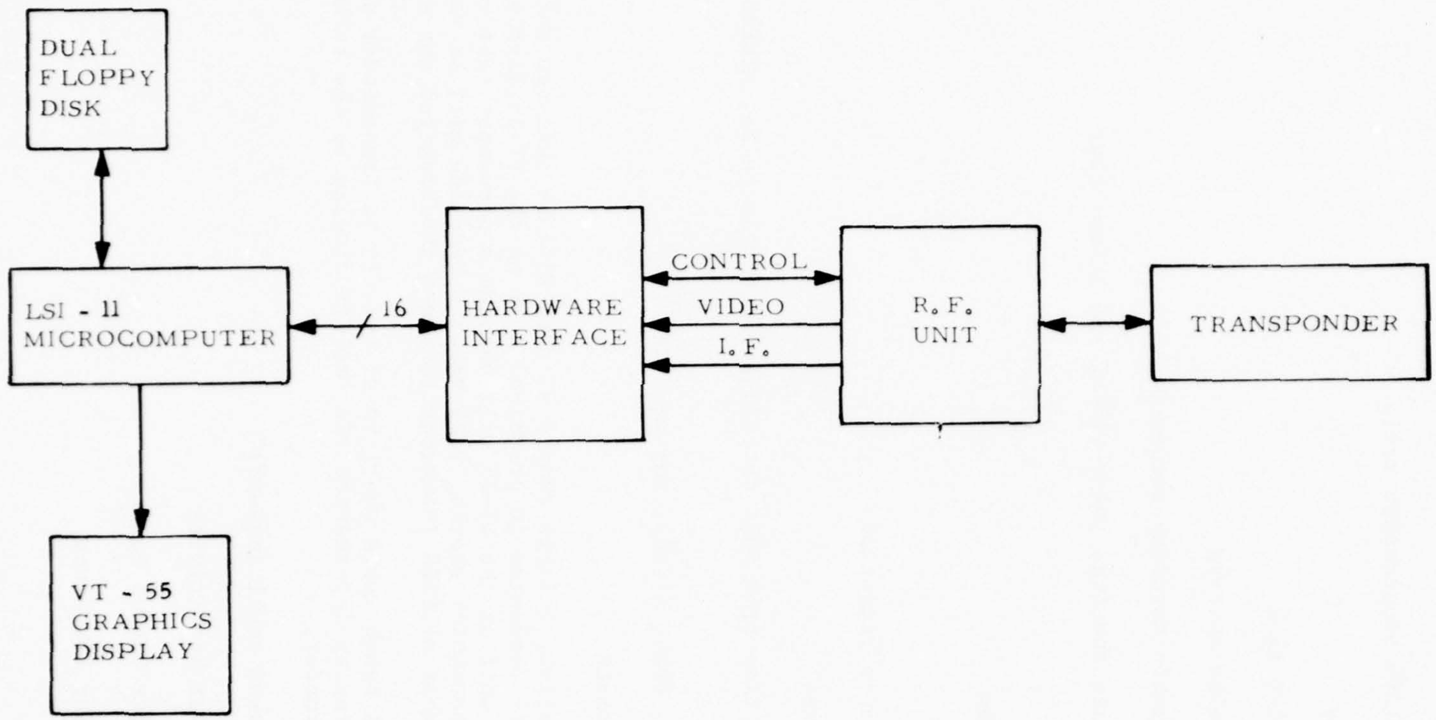


FIGURE 7. TRANSPONDER TEST SET - BENCH TEST CONFIGURATION

5. SLS

6. P1/P2, P1/P5 suppression ratio

7. Dead time

8. Suppression time

9. F1, F2 pulse spacing

10. DABS preamble decoding accuracy

11. Reply pulse spacing, pulse width, and pulse shape

12. Squitter

13. Delay time

14. Jitter

15. Interference rejection

16. Reply rates

17. Recovery time from DABS interrogator, single pulse, ATCRBS suppression pair

18. Lockouts, DABS, ATCRBS, and squitter

19. Reply formats

In this mode of testing, a large sample of data will be analyzed and the results of each test will be presented in graphical form on the VT-55 display. The built-in hard copy unit of the VT-55 will provide a permanent test record. In addition to these parameter checks, DABS message handling will be verified by cycling a large number of DABS interrogations and checking for any errors.

The second group of bench tests shall be of benefit in transponder alignment. These tests will display information via the CRT display to the technician aligning the transponder.

The parameters checked shall include:

1. Transponder Sensitivity

2. Transponder Output Power

3. Transponder Frequency

4. Dead Time

5. Suppression Time

6. Decoding Accuracy

7. Reply Data Limiting

4.4.2 VERIFICATION TESTS - BENCH

The functions to be evaluated require manipulation of controls and observation of lights. These tests are best accomplished by an operator and do not require the TTS. The following functions shall be checked:

Transponder Controls

a. Master Control (NO ALT, ON, STBY, OFF)

b. IFR or VFR SWITCH

c. IDENT Button

d. ANTENNA SELECTOR (TOP, BOTTOM, DIVERSITY)

e. CODE SELECTORS

f. ALERT BUTTON

g. DIM - TEST CONTROL

Transponder Indicators

a. DABS

b. ATCRBS

c. ALERT

d. ATCRBS LOCKOUT

e. ATCRBS/DABS LOCKOUT

4.4.3 VERIFICATION TESTS - LIVE

This group of functions requires flight tests and interface with the DABS sensor to adequately determine correct operation. These functions consist of the following parameters:

1. ATCRBS reply performance

2. DABS reply performance

3. Antenna Diversity operation

4. Surveillance performance

5. ATC message delivery

6. ALEC

7. Extended Length Message (ELM) devices (when available)

8. ATARS devices (when available)

4.4.4 RESULTS

After completion of the bench tests, the airborne system tests will be able to start with a high level of confidence in the operation of the avionics components. Any problems will have been corrected prior to the installation of the avionics in the test aircraft and the start of overall systems tests.

At the completion of live airborne system tests, the adequacy of the avionics functions for use in the DABS system operation will have been determined.

4.4.5 RESOURCES

MATERIAL

Three type A transponders
Three type B transponders
ATC Displays
ATARS/PWI Displays
ELM device(s)
Transponder Test Set
Oscilloscope
RF Signal generator
Spectrum Analyzer
Digital Counter

PERSONNEL

One Technician for equipment installation and maintenance of the avionics components.

One Engineer

4.4.6 OTHER AVIONICS

At the present time the design and configuration of avionics components such as ATC Displays, ELM displays, ELM message devices, etc., are not known. When these items are made available they shall be subjected to intensive testing and evaluation to assure compatibility with the DABS.

5.0 FUNCTIONAL PERFORMANCE TESTS

These tests will evaluate individual functional entities of the DABS sensor as distinguished from specific hardware or software groupings. These functional entities include the following: surveillance, performance monitoring and failure recovery, channel management, data link, network management and communications. The tests for each of these functional entities are discussed in sections 5.1 through 5.6 respectively. These functional tests will emphasize static inputs and simulated flight conditions.

In addition, computer functional tests, described in section 5.7, will be conducted in order to evaluate the performance of the several DABS computers used throughout the DABS sensor and to characterize the distributed processor architecture.

5.1 SURVEILLANCE

5.1.1 TEST OVERVIEW

These tests are to determine the overall surveillance functional performance utilizing simulated static target information. Tests will be conducted with both single targets and multiple targets. The tests will be conducted with various target input signal levels and various simulated fruit and DABS environments. The data collected will be the positional target data sent to the ATC facility and the information content of the surveillance file. Key parameters will also be recorded.

Surveillance functional performance will be characterized initially as a function of input signal level. Once signal level performance is characterized, then the functional performance as a function of the fruit and DABS environment will be determined. If degradation is identified, the cause will be investigated. This will include analysis of system parameters and the environmental conditions employed during the test. The system adaptation parameters related to surveillance will be manipulated to attempt to increase overall surveillance functional performance.

5.1.2 OBJECTIVE

The main objective of these tests is to determine the overall static capability of the surveillance function. For a single-target case, the measured results of interest are the fact that a target report was detected, and the positional accuracy of the target report in range, azimuth and altitude. For the multiple-target case, the area of interest is the ability of the system to resolve two or more closely spaced targets.

5.1.3 DATA COLLECTION

5.1.3.1 SINGLE TARGET - CPME

Initially, data will be collected using the CPME as a single-target source. The CPME will be operated in both the DABS and ATCRBS modes, and will be

configured to provide replies in each of the three range zones. The range, azimuth, and altitude word outputs to the ATC facility will be recorded, along with the range and azimuth of the updated track position which is stored in the surveillance file. With a known CPME position, it is desired to measure any difference in the recorded position data sent to ATC or stored in the surveillance file. Correspondence of the surveillance file position and the position data reported to ATC will be noted, along with ATCRBS code or DABS address. The predicted position stored in the surveillance file will also be noted.

The required data will be collected under various CPME signal levels and fruit and DABS environments. The number of false ATCRBS targets and associated tracks will be recorded as a function of fruit and DABS environment. Fruit will be generated as main and side lobes. The track firmness and history track firmness will give an indication of how well the single CPME track is maintained.

With the CPME operated in both the ATCRBS and DABS modes, the CPME should be caused to indicate an emergency. The number of scans from initiation of the emergency to the reported failure to the ATC system will be recorded. The surveillance file contents will also be recorded in order to determine that the track is maintained in the surveillance file during the emergency output. The contents of the surveillance file and the appropriate emergency bit set on the output message to ATC will be measures of the operation of this function.

For the DABS-only operation, it is required to record the number of roll call interrogations necessary to maintain the DABS track as a function of signal level, fruit and DABS environment.

It is also required to record the number of scans necessary to transition from All Call to Roll Call as a function of the fruit and DABS environment. The data to record these functions is available from the Channel Management Function. This data are available from the data extraction tape.

5.1.3.2 Single-Target - ARIES

The next series of tests involves the single target operation for each of the three range zones. The ARIES will be utilized as the target source for these tests.

Initially a series of tests will be conducted using the ARIES as a single target having minimum velocity. The ARIES targets will be in the same range within each range zone as employed for the CPME configuration tests. The same data that were collected for the CPME will be collected for the single ARIES target.

The ARIES will be set up to provide several targets having the same signal level at various azimuths for each of the three range zones. The same data that were collected for the CPME will be collected for each ARIES target. The test conditions of signal level, fruit and DABS environment will be the same as for the CPME tests. The data will show if there is any change in positional

accuracy capability. The data will be employed to characterize the positional errors of the ARIES relative to the CPME for each zone. The establishment of several targets in each range zone allows for an increase in the amount of data collected per unit of time.

5.1.3.3 Multiple Targets - ARIES

The series of tests using multiple targets is designed to evaluate the ability of the surveillance function to maintain identification and separation of targets in conflict situations.

For each set of target types, the minimum separation in range and azimuth that can be determined by the surveillance function will be defined. The data will consist of the delta range, azimuth and altitude obtained at the point where the system begins to degrade. Degradation is measured when the target report to the ATC facility ceases or is in error.

The scenario is such that the targets will be in conflict during various phases of their flight patterns. The positional information reported to ATC and the surveillance file data will be recorded. The capability of the surveillance function to separate these conflicting targets will be initially determined as a function of the slant range of the target from the sensor as measured by the signal level. Subsequently the ability to separate the targets will be determined as a function of fruit and the DABS environment.

With the two-target resolution case identified, it now becomes necessary to identify the functional performance of the surveillance function with more than two aircraft in close proximity. Various combinations of multiple target separations will be determined as functions of signal level, fruit and DABS environment.

5.1.4 RESULTS AND ANALYSIS

On a scan-by-scan basis, the delta difference between the known CPME position and both the reported ATC position and the surveillance file position will be calculated. A family of curves will be generated for both DABS and ATCRBS which will show the delta change in range, azimuth and altitude as a function of signal level for various fruit and DABS environments. Utilizing the calculated means and standard deviations of the CPME known positions, the reported ATC position and the surveillance file position; statistical tests will be applied to determine if these samples are from the same population.

A plot of the number of false targets, associated false tracks, and firmness number will be plotted as a function of signal level, fruit (both main beam and sidelobe) and DABS environment. Also associated with these results will be the measured ATCRBS code and DABS address as compared to the known information.

The data for the single ARIES case will be manipulated in a similar manner as for the CPME case. Statistical tests will determine if the data from each of the range zones is from the same population. Separate data plots for each range zone will be obtained. These results will be compared to those obtained for the CPME and a statistical measure of positional error attributed to the ARIES will be established.

For the multiple-target situation, plots similar to the single-target case will be obtained. In this case however, the delta range, azimuth and altitude will be the separation between targets. Track plots which show the track from good information to a coast condition will be obtained for each test condition. Track firmness will be plotted as a function of delta range, azimuth and altitude for each test condition. A scan-by-scan correspondence will be established between the track firmness and ATCRBS code recorded in the surveillance file and the track plot obtained from the DR and A tapes.

5.1.5 RESOURCES

MATERIAL

- CPME
- ARIES

PERSONNEL

- Two Engineers
- One Technician
- One Part-time Analyst

5.1.6 PREREQUISITES

The data extractor and I&P subsystems must have been tested including establishment of variable parameters in the I&P.

5.2 PERFORMANCE MONITOR/FAILURE RECOVERY

5.2.1 TEST OVERVIEW

As a result of significant advances in electronic technology, the Airway Facilities (AF) maintenance program is undergoing a transition with greater emphasis being placed on increased system reliability, maintainability, and availability. The acquisition of new systems without increasing the number of maintenance personnel required is a major goal of the AF service.

The concept of performance monitoring encompasses the operation, maintenance, and control of systems, and the transmission of data to a centralized point for monitoring operational status and for certification of system performance.

The functional performance testing will be conducted in two phases. This section of the test plan will deal with the specific functional performance tests and section 6.5 will discuss the overall or system tests.

Phase 1 shall determine compliance with the engineering requirements (ER-240-26) in both the performance monitor and failure recovery functions using simulated inputs. Phase 2 shall use scenario and flight tests (for which a data base exists) to enhance the performance monitor/failure recovery functions by determining gray zones and ambiguities in those parameters being measured and evaluated. Determinations shall be accomplished by observation of sensor operation and analysis of computer data gathered during the test and evaluation program.

5.2.2 OBJECTIVES

The objectives of the performance monitor testing are:

1. To determine the adequacy of the monitor in accomplishing the functions defined in the Engineering Requirement (ER-240-26).

2. To enhance the performance monitor operation by adding or deleting measured parameters and by maximizing those parameters being evaluated.

3. To determine gray zones and ambiguities in the measured parameters.

5.2.3 DATA COLLECTION

Computer printouts of the generated status messages and failure mode indications shall be collected to verify that the performance monitor hardware and software parameter measurements are in accordance with ER-240-26. Computer data shall be collected and evaluated to determine the satisfactory range of operation, region of ambiguity, and unacceptable limits of certain predetermined parameters. Status message printouts shall be analyzed to ascertain the effect different failure modes (introduced during the testing) have on

sensor operation. Track data will be collected to determine if a cause and effect relationship exists between failures and parameter values measured. Prior to the start of data collection, the interface between the performance monitor and the other DABS subsystems shall be verified. The following is the sequence of tests to be conducted during this level of testing:

1. Phase 1 Hardware Monitors

a. Transmitter - main power output for ATCRBS, DABS low power and DABS high power. Omni transmitter power for ATCRBS, DABS low power and DABS high power.

b. Receiver - monitored output in response to a known input test pulse for each receiver video channel. Receiver noise output for each video channel.

c. Monopulse outputs for test inputs simulating targets on and off boresight.

d. Real Time clock status

e. Azimuth register status

f. Tests performed using the CPME - initial acquisition, DABS acquisition, DABS roll-call surveillance, ATCRBS surveillance, Comm A-Comm B.

2. Phase 1 Software Monitors - Data will be gathered to determine that the performance characteristics of the following software monitors are in accordance with the ER.

a. Track count for both DABS and ATCRBS targets.

b. Delivered messages on a scan basis.

c. Expired messages per scan.

d. Reply storage overflow flag.

e. Input message queue overflow flag.

f. Output message buffer overflow flag.

g. Active message file overflow flag.

h. Collimation difference table.

i. Beacon strobe reports.

j. Adjacent sensor status message and CPME track data message.

k. ATARS test message and status message.

l. Status messages for each of the above functions and the various failure modes shall be checked for accuracy and adequacy.

m. Adjacent sensor status

3. Phase 1 Failure/Recovery Surveillance Tests - These tests shall be designed to establish the performance of a single DABS sensor with respect to providing surveillance processing. The quality of the surveillance data will be established by comparing sensor performance with that achieved with no failure. The criteria that will serve as a basis for these comparisons shall be those established under the single-sensor surveillance tests. Additionally, changes to surveillance capacity and response and recovery times will be recorded. An external recording device will be used to record surveillance and related communications messages for these tests.

Message and Code Information Function - The performance of a single DABS sensor in maintaining a flow of message and code information between the simulated/live aircraft and the DABS sensor will be established for various levels of failures. Performance will be based on system capability and quality of data obtained under normal conditions. Criteria for determining system performance will include: (1) message response time, (2) error in message content, (3) changes in data handling capacity, and (4) performance following recovery.

4. Phase 2 - Using scenarios with known tracks, targets, reports, commands, messages, etc., and aircraft flights for which the output data are documented; selected parameters will be varied and the effects of this variation on the output determined. The goal of the Phase 2 tests is to make improvements in the basic functional operation of the performance monitor.

a. Hardware Monitors - Data shall be obtained which indicate the operable range of values over which the indicated hardware parameters can be monitored and any areas of ambiguity. As the T&E of DABS progresses, other parameters will be subjected to variations. The following initial parameters shall undergo Phase 2 tests:

(1) Transmitter - Power levels shall be varied on the directional and omni-directional transmitter modes. Power levels will be plotted against a target track to see the effect and to determine if the status messages accurately foretell the degradation if any in the target track.

(2) Receiver - Noise input to the receiver shall be varied over a sufficiently broad range to determine if the target track undergoes degradation and if the status messages accurately indicate the situation.

b. Software Monitors - Data will be obtained which will indicate the operable range of values over which the specified software parameters can be monitored and any areas of ambiguity noted. The following comprise the initial software parameters to undergo Phase 2 testing:

(1) Track count for both DABS and ATCRBS targets.

(2) Collimation difference table.

(3) ATARS test message and status message.

5.2.4 RESULTS AND ANALYSIS

The following pertinent information shall be available at the completion of the Performance Monitor functional testing:

1. False alarm rates as a function of parameter tolerances.

2. Parameter gray zones

3. The degree to which marginal operation is determined.

4. Adaptability to parameter changes and ease of implementation.

5. Failure modes that result in a reduction of DABS functions as defined in the ER.

5.2.5 RESOURCES

MATERIAL

Test Target Generator
ARIES
Oscilloscope, Voltmeter and other Standard Site Test Equipment

PERSONNEL

One Engineer
One Technician
One System Analyst

5.2.6 PREREQUISITES

All tests essential to determining sensor operation are to be completed prior to the start of performance monitor functional testing.

5.3 CHANNEL MANAGEMENT

5.3.1 TEST OVERVIEW

The performance of the DABS greatly depends on the efficient use of the rf Channel, which is regulated by channel management. The performance evaluation of channel management is divided into three phases. Phase one will be the verification of the channel management programs to determine that the DABS functional implementation complies with the DABS Engineering Requirement (ER-240-26). The individual tasks will be tested through the use of test inputs. The second phase will consist of stand-alone functional tests for all channel management functions interacting with each other by means of test drivers. These first two phases, described in this section (5.3), utilize simulated aircraft only. The final phase will consist of system tests which will be included in the surveillance system tests described in section 6.2 of this document. This phase shall use both simulated and live flight tests.

5.3.2 OBJECTIVES

The objectives of the channel management performance tests are:

1. Verify that the channel management function has been implemented as specified in ER-240-26.

2. Determine the performance of channel management with respect to the efficient use of the rf channel under simulated conditions.

3. Characterize and evaluate channel management performance in terms of its ability to successfully schedule transmission under varying traffic conditions and message types.

5.3.3 DATA COLLECTION

Phase 1 will consist of desk checks of the channel management programs to verify compliance with the Engineering Requirement. Several test scenarios will be loaded into the memory as inputs to the individual channel management tasks (Transaction Preparation, Target List Update, Roll-Call Scheduling and Transaction Update). The following information will be obtained through the use of core dump following each task execution.

1. Active Target file (list)
2. Active Message file (list)
3. All-Call Specification file
4. AZSTU Data file
5. Channel Management file
6. DABS Reply file
7. DABS Reply Control file

8. MCU Interface Buffer

9. Release Target file

10. Schedule Buffer

11. Surveillance file A

In the second phase, the data extraction software will be used to load various scenarios which were generated by the scenario generator. The scenario generator is a program which generates the flight pattern scan by scan according to the input, which contains the description of each aircraft ID, position with respect to the sensor, velocity, heading, climb rate, etc. The DABS or ATCRBS driver is then employed to drive the channel management programs for the functional interactions. The data extraction software will be instructed to extract the information (files) listed above in phase one following each DABS period.

The DABS and ATCRBS drivers scenarios will be converted to an ARIES scenario. The channel management programs will then be exercised by using ARIES as input and the same information will be extracted to provide for a comparison between the results obtained with the ATCRBS and DABS drivers and ARIES scenarios. The scenarios used for the channel management functional tests will fall into the following categories:

1. The number of targets in a 90° quadrant will be varied between 10 and 400 targets in increments of 10. The targets will be uniformly distributed within the wedge.

2. All targets within a sector (11.25°) will be concentrated in the direction of maximum and then minimum ranges.

3. Various mixtures of target types.

4. The loading for a sector (11.25°) will be a maximum of 50 targets.

5. The number of reinterrogations per beam width.

6. Data block format types include:

   a. Standard

   b. Uplink

   c. Downlink

   d. Extended-Length Message (ELM)

5.3.4 RESULTS AND ANALYSIS

The information recorded on the magnetic tape through the use of data extraction software will be used as inputs to the channel management analysis programs. These programs will determine the performance and functional capability of the channel management in terms of its capability to process the maximum number of targets for both homogeneous and peak loading traffic densities. The data will be analyzed as a function of target mixture, target load, data format, probability of reinterrogation being scheduled given an unsuccessful initial interrogation, the probability of successful transaction of ELM messages of N segments for various traffic conditions, and the utilization of the available time by the scheduling algorithms.

5.3.5 RESOURCES

MATERIAL

Test Drivers (DABS, ATCRBS)
Scenario Generator
ARIES
Data Reduction and Analysis Programs
AZSTU Dummy Simulation Board
Site Test Equipment

PERSONNEL

One Engineer
One Technician
One System Analyst
One Programmer

5.3.6 PREREQUISITES

None

5.4 DATA LINK

5.4.1 TEST OVERVIEW

The ojectives of the Data Link (DL) tests are (1) to evaluate the error detection and correction capabilities of the code used in the DABS uplink and downlink DL messages and (2) to evaluate the ability of the DABS Sensor to correctly process simulated DL messages for which the transmission parameters can be selectively varied.

The first objective involves the evaluation of the DL code itself, hence does not require an actual DABS Sensor or Transponder. Due to the large number of possible error combinations, considerable testing time is required to comprehensively test the error detecting and correcting capabilities of the code. Therefore, the evaluation of the code itself will be accomplished by means of a bench test in which the DABS error detection and correction circuitry will be simulated by a breadboard-type code tester controlled by a microprocessor. This bench test can therefore be started before the delivery of the actual DABS Sensor to NAFEC. These tests will determine whether the error detection and correction capability of the DL code, which is known to perform properly for a 72-bit message length, will perform properly for the standard 112-bit DL message.

The microprocessor will have the capability of imposing error bursts 24 bits or less in length anywhere within a standard size 112-bit DL message. All possible combinations of these error bursts will be generated. The bench tests will determine whether (a) all uncorrupted messages will be accepted, (b) all induced errors within specified limits will be detected, and those errors occurring in low confidence level bit positions will be corrected, and (c) messages containing errors outside the specified limits will be rejected.

The second objective involves the inputting of simulated DL messages from the ARIES or Test Target Generator (TTG) into the DABS Sensor. These simulated messages shall utilize the bit configuration most susceptible to adverse conditions as determined from the code tests. The transmission parameters to be varied include frequency, signal strength, and monopulse Δ / Σ ratio. The second test category (simulated tests) will determine the optimum transmission parameters for the DL messages and the optimum link reliability.

Critical resources for the simulated tests include the ARIES or TTG. This test category also requires an operational DABS Sensor. The bench test should be completed before the simulated tests start in order that the worst case bit configuration as determined by the bench test be used in the simulated tests.

5.4.2 OBJECTIVES

The objectives of the Data Link (DL) tests are:

1. To evaluate the error detection and correction capabilities of the code used in the DABS DL messages.

2. To evaluate the ability of the DABS Sensor to correctly process simulated DL messages for which the transmission parameters can be selectively varied.

Note that the first objective involves the evaluation of the message code itself while the second objective concerns the processing of messages by an actual sensor. The testing will therefore be conducted in two phases, each corresponding to one of the two objectives. These phases are: (1) a bench test, and (2) a sensor test.

5.4.3 DATA COLLECTION

1. Bench Test - The evaluation of the message code itself will be accomplished by means of a bench test in which the error detection and correction circuitry of the DABS Sensor will be simulated by a breadboard-type code tester controlled by a microprocessor. The microprocessor will be used to control the code tester and to establish the initial conditions for each run. An associated computer system will provide error printouts.

The microprocessor will impose error bursts 24 bits or less in length anywhere within a standard size 112-bit DL message. All possible combinations of these error bursts will be generated.

To reduce total test time, the various error codes will be superimposed on and tested with the all-zero code vector. For each error condition, the syndrome will be calculated and the correction process will be applied to the erroneous code. The resultant vector should be the all-zero vector. If errors were incorrectly decoded, or if the correction process were in error, the resultant vector will not be all zeros, and a malprocessing condition will be recognized. The computer will accept a code word from the tester, will decode the malprocessed condition, and will print an appropriate message identifying the conditions which caused incorrect code operation.

Some self-checking circuitry is included in the code tester logic. Malprocessing conditions caused by catastrophic failures in the test set will result in different printouts from those due to incorrect operation of the code itself. All malprocessing conditions, whether due to incorrect code operation or tester logic failures, will cause the computer to stop operation after the malprocessing message printout. In this manner, automatic operation will continue without operator intervention until a malprocessing occurs. After a stoppage which is caused by any malprocessing, operator intervention is necessary and proper steps must be taken to reinitiate automatic testing. The test sequence is arranged in a binary fashion so that from a malprocessing printout, the initial conditions for the next test condition may be determined.

The computer printout will consist of a test # field, a G/N field, and a comments field. The test # field will consist of two octal numbers indicating

respectively the error combination employed and its position within the DL message. The G/N field will consist of a single alphanumerical character which will show whether the error condition indicated by the test # was properly recognized and corrected (G) or if a malprocessing occurred (N). The comment field will consist of up to 50 alphanumerical characters which indicate the type of malprocessing noted.

2. Sensor Test - In this test phase, simulated downlink DL messages from the ARIES or TTG will be inputted into the DABS sensor. These simulated messages shall utilize the bit configuration most susceptible to adverse conditions. The bit configuration used shall be the worst case code detected during the bench test phase. If no such code is found, then a bit configuration which will most thoroughly exercise the DL circuitry in subsequent system tests will be used.

The following quantities will be recorded during the sensor test phase:

1. Number of errors within a given message.

2. Number of messages with errors versus number of transmitted messages.

3. Number of corrected messages in relation to the number of transmitted messages.

4. Number of messages received without errors in relation to the number of transmitted messages.

Each of the above items will result in a family of curves with the simulated environmental conditions as running parameters.

Using the TTG with rf generator, the following parameters will be varied:

Carrier Frequency: 1087 MHz to 1093 MHz, 0.3-MHz steps

Signal Strength: -70dBm to -20dBm, 10-dB steps

Δ/Σ Ratio: -2 to +2, 9 steps.

For each of the above test conditions, at least a hundred transmissions will be generated. The number of tests will be proportional to the error rate. The minimum number of interrogations for a given test condition will be 100 and the maximum limit will be fixed at 1,000.

Using the ARIES unit, the worst case traffic load condition will be simulated. During this test, only the relative signal levels of the desired DABS signal and the interference signals will be varied. The position of the target will be adjusted to the boresight value and the carrier frequency will be as close to the nominal value as possible.

The tests using the ARIES will check the DL operation as it is affected by interference signals. At the same time, the data handling capacity of the software and the rest of the ground system hardware will be verified under maximum load conditions.

A number of processing constants which pertain to the information processing must be exercised during the sensor tests. An example of this is the constant K, which determines the absolute value of the acceptable difference between the average amplitude of previously received information bits and the amplitude of the subsequent bit pertaining to the same message. This constant has a direct bearing on the number of messages which may be acceptable but does not affect the accuracy of the estimate of the target's position.

The constants which are involved in monopulse estimates will be adjusted during tests which precede the DL test. For example, the constant involved in the Q Σ signal from the Receiver Unit will be determined during the Receiver test. The tests which must precede the DL simulation test are identified below.

The rate of message transmission will be kept at the maximum specified to exercise the DL software in the sensor. Contents of the input and output queues will be stored on magnetic tape. In this manner, the number of messages processed will be monitored and deletion rates determined.

5.4.4 RESULTS AND ANALYSIS

1. Bench Tests - The bench test phase of the DL tests will determine whether the error detection and correction capability of the DL code, which is known to perform properly for a 72-bit message length, will perform properly for the standard 112-bit length DABS DL message. Specifically, the bench tests will determine the degree to which:

   a. All uncorrupted messages will be accepted,

   b. All induced errors within specified limits will be detected, and those errors occurring in low confidence level bit positions will be corrected.

   c. Messages containing errors outside the specified limits will be rejected.

2. Sensor Tests - The general result of the sensor test is that the operation of the DABS Processor will be verified as it pertains to its data handling capabilities. Specific results will be as follows:

   a. Determination of best values for the various constants which are required for optimum sensor adjustment.

   b. Determination of the overall link reliability of the DL. This is equal to the ratio of the number of good accepted messages to the total number of messages transmitted with the channel parameters within the specified limits.

   c. Determination of sensor sensitivity to individual parameter variation, i.e., error rate versus carrier frequency. This will be determined from the individual tests where only one parameter is varied.

d. Determination of DL software limitations for maximum data rate conditions.

5.4.5 RESOURCES

MATERIAL

Logic Analyzer
Microcomputer System
Code Tester Logic
Test Target Generator (TTG)
ARIES Unit
RF Head for TTG
Data Extraction and Reduction Programs

PERSONNEL

One Technician

One Engineer

One Programmer

5.4.6 PREREQUISITES

1. Code Test - None

2. Simulated Test

The sensor must be operational as determined during acceptance tests. Receiver, Transmitter, and Processor subsystem tests must be completed to insure all adjustments of processing constants have been completed.

5.5 NETWORK MANAGEMENT

5.5.1 TEST OVERVIEW

Network management will be tested in two different modes; namely "netted" and "stand-alone." The netted mode is characterized by the fact that the individual sensors are connected to each other with telephone lines. The sensors themselves, using predefined coverage maps and "network management" software, determine which sensor has priority in providing surveillance coverage and data link communication to an aircraft in areas of overlapping coverage. This mode is described in detail in FAA-ER-240-26, volume 3, and is being implemented by TI. The test plan for the netted mode will be prepared at a later date and will be included in the overall test plan for multisite testing which is expected to commence in the 1980 time frame. At this time, only the functions necessary to validate the ER are of concern to the FAA and these functions should be acceptance tested by TI and monitored by the FAA to insure compliance. If some of the functions are not tested by TI during the factory or field testing, then NAFEC will conduct those particular tests necessary to determine if the function fulfills the overall objective.

The second mode is referred to as the stand-alone with overlapping coverage network management system. In this mode there are no ground data links between the DABS sensors, therefore, the connected ATC facilities are called upon to provide most of the necessary coordination for the sites. The changes between this mode and the one above are described by D. Reiner in his paper "Network Management Revisions For The DABS Stand-Alone Mode." At the present time, the stand-alone design has not yet been implemented. This test plan primarily addresses the stand-alone mode of network management. However, many of the functions of a single DABS site with no overlapping coverage as well as the netted mode will be tested and evaluated at this time.

In order to fully test the network management function, three phases are anticipated; namely "software task testing." "functional testing," and "system testing." The first phase concerns itself with software task testing. In Phase I, two different types of testing will be used to check out the delivered software programs; namely, "Desk Checking," and "Unit Test Drivers." The first type involves desk checking the tasks and subtasks against the engineering requirement to insure that all the functions of network management are coded into the operational program. This will be accomplished by both TI and NAFEC. The second type of Phase I testing concerns itself with unit testing each of the individual tasks and subtasks using software unit test driver programs. These tests will be accomplished by TI and will be examined by NAFEC. If there are any areas which NAFEC feels are not tested or not tested in sufficient detail, then they will be tested when the DABS sensor is made available to NAFEC personnel.

Phase II testing, which is addressed here, concerns itself with functional testing of the total network management system operating with the remaining portion of either the DABS mission software or both the DABS software and hardware. This will be accomplished by using either the aircraft simulator

program to simulate the front end of the DABS sensor or by using the ARIES equipment in order to fully exercise network management processing. Texas Instruments will conduct factory and field testing prior to acceptance of th system by the FAA. These tests will be augmented by NAFEC during its test and evaluation of the DABS System. The functional tests will determine to what degree network management performs its overall mission.

Phase III will deal with system testing and will involve more than one senso This phase will be covered in section 6.6 of this report.

5.5.2 OBJECTIVES

The purpose of these functional tests is to determine and characterize the network management operations in terms of insuring adequate surveillance of and communication service with aircraft which are located in areas of single as well as multiple sensor coverage. The version of network management to b tested will be the stand-alone mode of the DABS Sensor. As was stated above, many of the functions of the netted mode, especially in the area of single coverage, will be characterized during these tests.

5.5.3 DATA COLLECTION

Data will be collected in order to determine how well network management per forms its many functions under a variety of input conditions derived from specific scenarios. The input conditions will be established by developing scenarios for both the aircraft simulator and the ARIES equipment. The data extraction software will be used to record the appropriate input and output data on magnetic tape for further offline reduction and analysis. The speci data to be collected includes, but is not limited to, the surveillance file each target in the system, the coverage map and reference subfiles in the ma and the messages which were generated and/or received.

The first area of testing concerns itself with simulated uncontrolled DABS aircraft which change track status, cross cell boundaries, and enter sensor overlap areas. The functions to be checked out in this area are as follows:

1. Target Track Status
2. Sensor Priority Status
3. Adjacent Assigned Sensors
4. Coverage Map Cell.
5. Data Link Activity
6. Altitude Correction
7. ATCRBS Lockout
8. DABS all-call lockout from an auxiliary sensor
9. DABS Lockout
10. Sensor Priority for:
    a. Air-To-Ground Messages
    b. ALEC and Synchro Service
11. Roll-Call Inhibit

The parameters to be inputted and varied are:

1. Number of uncontrolled DABS aircraft
2. Aircraft range, azimuth, altitude and reply type
3. Coverage map parameters varied as a function of cell position.

The parameters to be outputted are:

1. The network management lists in the surveillance file
2. Data link capability messages to ATC and ATARS

The second area of testing concerns itself with controlled DABS aircraft which enter sensor overlap areas and which receive primary assignments from ATC. The functions to be checked out in this area are as follows:

1. Sensor Priority Status
2. Adjacent Assigned Sensors
3. Data Link Activity
4. Sensor Priority for:
   a. Air-To-Ground Messages
   b. ALEC and Synchro Service

The parameters to be inputted and varied are:

1. Number of Controlled DABS Aircraft
2. Aircraft Range, Azimuth, and Altitude
3. Coverage Map Parameters
4. Messages from ATC facility

The parameters to be outputted are:

1. The network management lists in the surveillance file

The third area of testing concerns itself with surveillance hand-off procedures. The functions to be checked out in this area are as follows:

1. ATCRBS Lockout
2. DABS All-call lockout from an auxiliary sensor
3. DABS Lockout

The parameters to be inputted and varied are:

1. Number of DABS aircraft
2. Aircraft range, azimuth, and altitude
3. Coverage map parameters

The parameters to be outputted are:

1. The network management lists in the surveillance file.

The fourth area of testing concerns itself with adjacent sensor failure and recovery. The functions to be checked out in this area are as follows:

1. Sensor priority status
2. Adjacent assigned sensors
3. Special mode

The parameters to be inputted are:

1. Number of DABS Aircraft
2. Aircraft range, azimuth, and altitude
3. Coverage map parameters
4. Messages from ATC

The parameters to be outputted are:

1. The network management lists in the surveillance file

5.5.4 RESULTS AND ANALYSIS

The data collected from the network management list in the surveillance file will be tabulated by scan for every aircraft and for each of the above mentioned functions. An example of the table is listed below.

Scan num	ACID	Track Status	Sensor Priority Status	Adj. Assigned Sensors	Cov map cell	Spec mode	Data Link Act.	Alt Corr	ATCRBS Lock
1	N1234	S4	P	2/3	205	Y	Y	2	Y

DABS All-Call Lock	DABS Lock	Sensor Priority Air/Alec	Roll Call Inhib	A/C range	A/C azimuth	A/C Alt	A/C Contr	IFR
Y	Y	Y/Y	N	45	25.0	180	Y	Y

No data link capability messages sent to ATC this scan.

No sensor priority messages received from ATC this scan.

The data will then be compared for accuracy with the expected outputs which will be tabulated independently of the testing. The results from the comparisons will determine whether network management performed its assigned tasks.

An analysis will also be performed to determine the number of scans or the percent of time in which each aircraft was out of contact with each of the DABS sensors in the coverage area and with all the DABS sensors taken as a group. The acquisition time from when the aircraft was in sight of the antenna until it was acquired by each of the sensors will also be determined. The results will be tabulated from the above analysis and a conclusion will be made as to the effectiveness of the stand-alone network management function in terms of providing continuing surveillance of and communication with aircraft.

5.5.5 RESOURCES

MATERIAL

DABS Sensor
DABS Network Management Software for Stand-Alone configuration
Network Management Driver
ARIES

PERSONNEL

One Mathematician
One Technician

5.5.6 PREREQUISITES

The prerequisites required to conduct and report the tests before the 1980 TDP are as follows:

1. DABS network management stand-alone software must be implemented and checked out by September of 1979.

2. Network management driver must be implemented and checked out by September of 1979.

5.6 COMMUNICATIONS

5.6.1 TEST OVERVIEW

The performance test is responsible for verifying the data transmission software of the DABS sensor. The testing will consist of verification of the CIDIN message processing, surveillance message processing, FEP processing, message routing, and data link processing. The Communications Functional Performance Test will concentrate on the logical paths of the entire communications subsystem. Emphasis of this test will be placed on communications software task interfacing and the logical data flow (messages) throughout the communications subsystem. During the performance testing, message formats will be varied and error logic invoked to ensure proper operation. The functional performance test will provide the basis for the communications system test (section 6.7). During system testing, the emphasis will be placed on the data flow from the external ATC facilities to the aircraft (simulated).

5.6.2 OBJECTIVES

The primary objective of the Communications Functional Performance Test is to verify the correct data transmission of the DABS sensor. In order to access the communication's performance, the following objectives must be examined:

1. The assurance that communication subsystem software operates in compliance with the engineering requirements of FAA-ER-240-26.

2. The assurance that all link protocols are properly implemented.

3. A determination of the performance characteristics and design adequacy of the communications software.

5.6.3 DATA COLLECTION

The functional performance test will concentrate on evaluating the data paths of the entire communications subsystem. The test will rely primarily on the collection and analysis of communication messages and files. A software program, known as a driver, will reside in a spare DABS computer providing inputs and extracting data during the test. Figure 8 contains a general flow diagram of the communications driver. Upon initialization of the test (1) the program will be loaded into memory and files modified where necessary. Known inputs will be read from magnetic tape (2) and fed into the communications subsystem (3) for test operation. The data extraction software (4) will output copies of communication files, formatted messages, and global memory parameters to a magnetic tape for later analysis. The communications driver will test messages in both the NAS-to-DABS and DABS-to-NAS data transmission configurations.

Figure 9 displays the data flow of the five functional areas during the communications test:

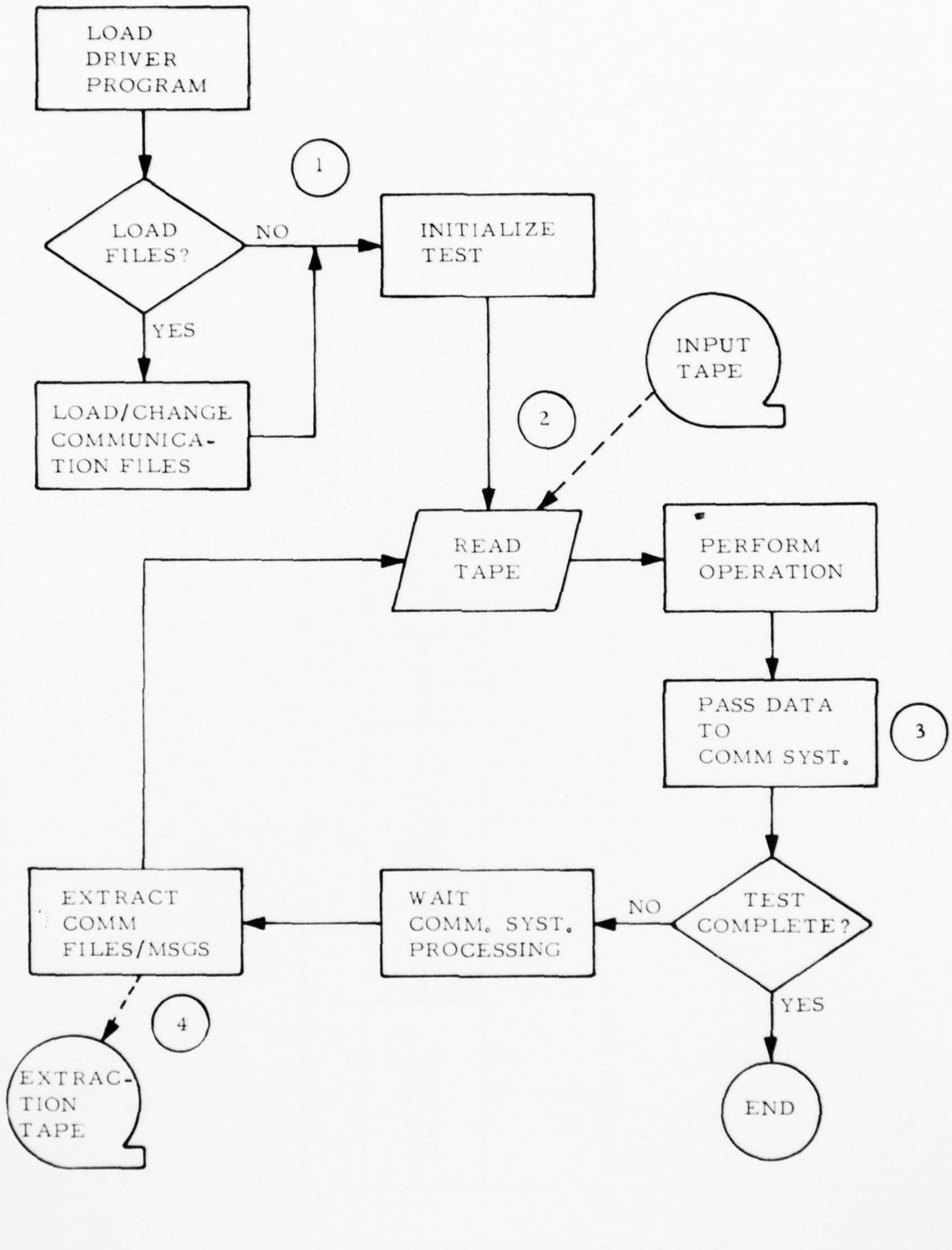


FIGURE 8. COMMUNICATIONS SOFTWARE TEST DRIVER

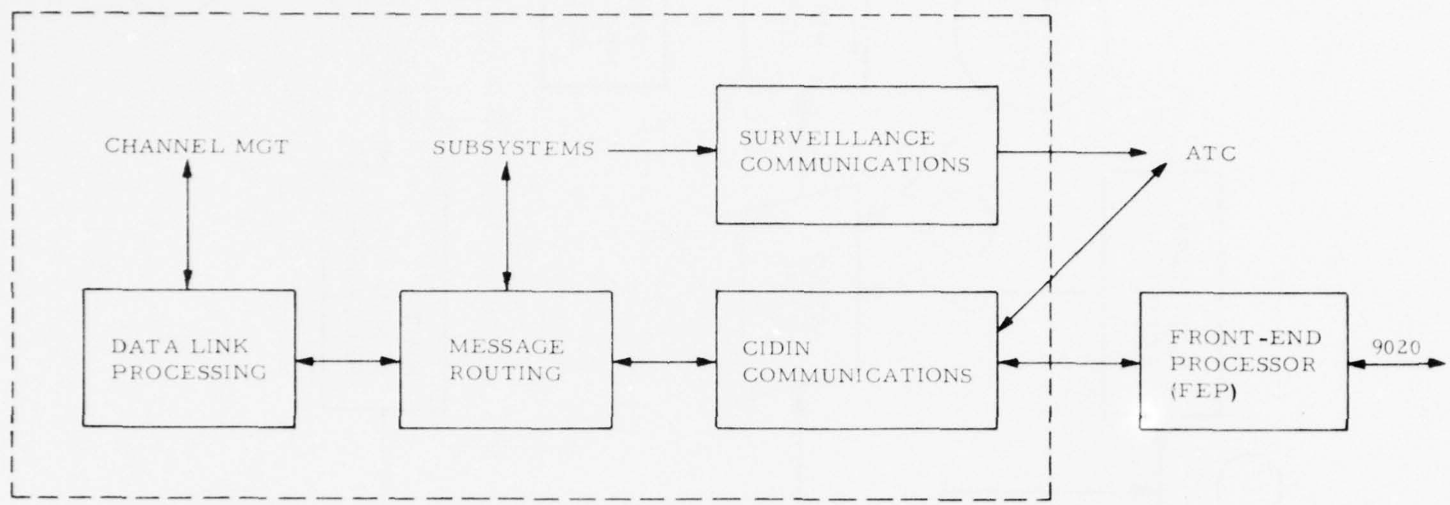


FIGURE 9. COMMUNICATIONS FUNCTIONAL RELATIONSHIP BLOCK DIAGRAM

1. Data link processing manages the uplink and downlink messages with participating DABS-equipped aircraft;

2. Message routing transfers incoming messages to local subsystems;

3. Surveillance communications transmits all surveillance reports to ATC facilities:

4. CIDIN communication controls all communications messages with ATC facilities and adjacent sensors; and

5. Front-end processor (FEP) is used to interface the three DABS sensors with the 9020 system using the existing 9020 input/output hardware. The FEP also converts the data communication between the CIDIN protocol and the 9020 protocol.

Figures 10, 11, and 12 provide a systematic breakdown of the communciations subsystem into two areas: internal (1.1-intrasite) and external (1.2-intersite) communications. A further division displays the five functional areas as defined above.

The interrelationship of these functions will be evaluated during communications processing. The following types of DABS sensor input messages will be tested:

1. NAS-to-DABS Uplink Messages
2. NAS-to-DABS Status/Control Messages
3. ATARS-to-DABS Sensor Messages
4. ATC to Message Routing
5. Remote Sensor to Local ATARS Messages, and
6. Sensor-to-Sensor Messages

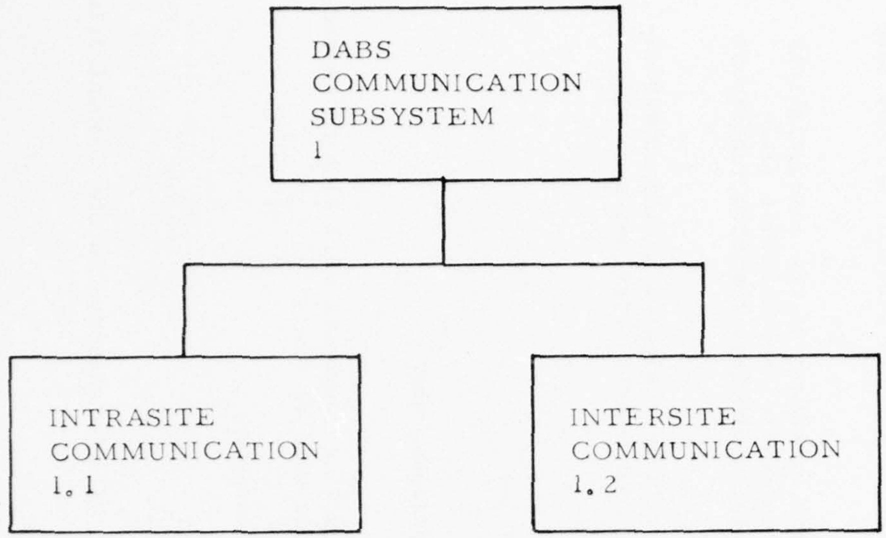
Message acceptance, rejection, and delay notice responses will also be tested. The following types of DABS output messages will be tested:

1. Performance Monitoring Status Messages
2. Data-Link Processing Messages
3. Network Management Messages, and
4. Surveillance Processing Messages

The evaluation of DABS protocol operation will be examined in the Communications System Test (section 6.7).

5.6.4 RESULTS AND ANALYSIS

The data collected during the functional tests will be communications messages, files, and software parameters recorded on magnetic tape. At the conclusion of each test, the contents of the tape will be printed and compared with the expected results. Any software or ER discrepancies will be corrected and tested again for proper operation. Inputs will be varied to insure correct and incorrect message parameter construction. Statistical data will be maintained on errors encountered during data transmission within the sensor communications subsystem. Additionally, the sensor data transfer capabilities (message transfer rate) will be calculated.

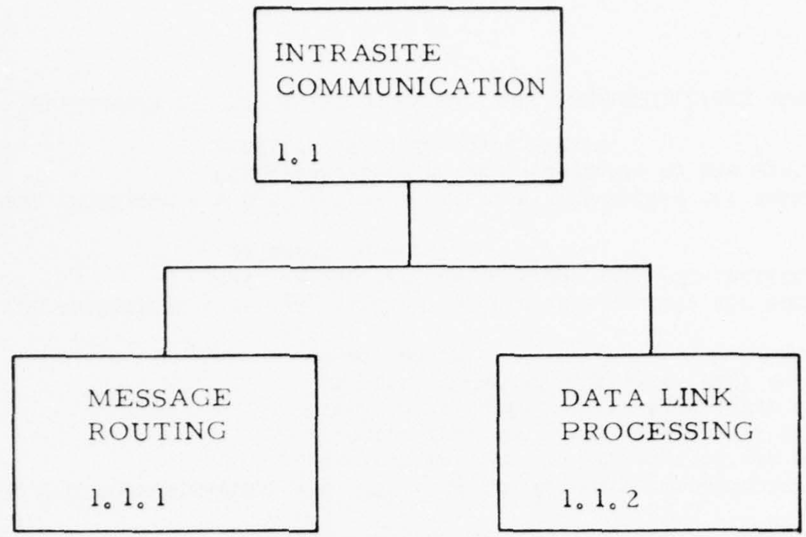


1 COMMUNICATION SUBSYSTEM - refers to the combined software necessary to route data within the sensor and exchange messages with external facilities.

1.1 INTRASITE COMMUNICATIONS - refers to the functional area software required to manage message and data communications within the sensor.

1.2 INTERSITE COMMUNICATIONS - refers to the functional area software required to control and monitor the transfer of data from a sensor to external facilities.

FIGURE 10. BREAKDOWN OF DABS COMMUNICATIONS SUBSYSTEM INTO INTRASITE AND INTERSITE AREAS

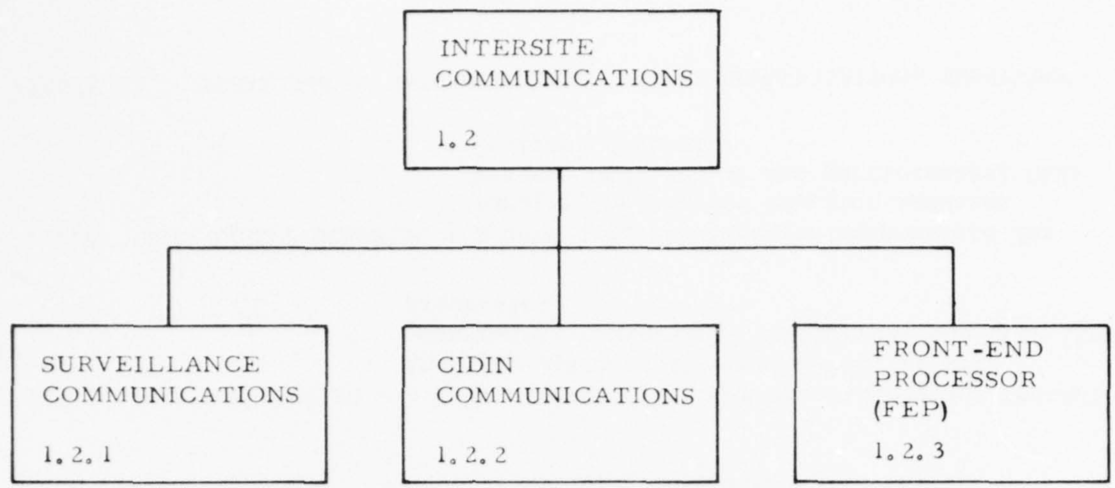


1.1 INTRASITE COMMUNICATIONS - refers to the functional area software required to manage message and data communications within the sensor.

1.1.1 MESSAGE ROUTING - a DABS software function responsible for routing incoming messages to local ATARS, network management, performance monitoring, and data link processing.

1.1.2 DATA LINK PROCESSING - a DABS software function responsible for managing uplink and downlink messages between DABS sensor and participating DABS equipped aircraft.

FIGURE 11. BREAKDOWN OF INTRASITE AREA OF DABS COMMUNICATIONS SUBSYSTEM



1.2 INTERSITE COMMUNICATIONS - refers to the software required to control and monitor the exchange of data between the DABS sensor and external facilities.

1.2.1 SURVEILLANCE COMMUNICATIONS - a DABS software function responsible for controlling the transfer of all surveillance reports from the local DABS sensor to ATC facilities and transferring radar reports from the Production Common Digitizer (PCD) to the local DABS sensor.

1.2.2 CIDIN COMMUNICATIONS - a DABS software function responsible for controlling all communications messages with ATC facilities and adjacent sensors.

1.2.3 FRONT-END PROCESSOR - a DABS software function responsible for reformatting CIDIN data into a form acceptable by the System Support Facility (SSF) En route system.

FIGURE 12. BREAKDOWN OF INTERSITE AREA OF DABS COMMUNICATIONS SUBSYSTEM

At the conclusion of the communications test, all the data collected will be analyzed and reported upon in the Communications Functional Performance Test Report. Recommendations for design or implementation changes will be included in the report, along with a summary of the communications capabilities.

5.6.5 RESOURCES

MATERIAL

Spare computer - communications test driver
Program Support Equipment (PSE) - develop driver software
NAFEC 9020 computer (SSF) - testing FEP interface
FEPTST and DABTST - 9020 software for FEP testing
Communications Test Driver - 990/10 software
System Test Console - extract communications data
Data Extraction Software - conduct communications software tests
Magnetic Tape Units - two; input and extraction

5.6.6 PREREQUISITES

1. Data Extraction Software Testing
2. Test Driver Software Testing

5.7 COMPUTER FUNCTIONAL PERFORMANCE

5.7.1 TEST OVERVIEW

These tests will be conducted to evaluate the performance of the architecture of the computers used in the DABS engineering model sensors, and to characterize the distributed processor architecture. A combination of hardware monitoring and software monitoring techniques will be used to collect data on the performance of the DABS computers.

5.7.2 OBJECTIVES

The Computer Performance Evaluation Tests will be conducted in order to characterize the distributed processor architecture. This characterization will be in sufficient detail to allow for the writing of functional specifications for the production contract computers.

Additionally, the operational suitability of the voting computer concept will be evaluated. The techniques used in the computer performance evaluation will also be made available for use in evaluating the software delivered by TI and to evaluate software modifications.

5.7.3 DATA COLLECTION

Hardware and software techniques will be developed to allow for the following system measurements:

a. Tiline bus contention delays
b. Surveillance data throughput times
c. Communication data throughput times
d. Processor busy time
e. Processor/task throughput times
f. Global memory transaction times
g. Global memory utilization
h. Common file contention profile.

Data on the above parameters will be collected under various controlled load conditions using the ARIES as an input data source.

5.7.4 RESULTS AND ANALYSIS

The data collected will be analyzed to characterize the architecture of the delivered DABS sensor. Based upon the data collected, projections will be made as to the capacity and expandability of the delivered system. In the area of expandability, both the areas of maximum possible expansion size and the resulting increased capacity will be evaluated.

5.7.5 RESOURCES

MATERIAL

Hardware Monitoring Equipment

PERSONNEL

Two Engineers

One System Analyst

5.7.6 PREREQUISITES

The following prerequisites must be completed prior to the start of these tests:

a. Modifications to the DABS mission software to permit collection of software monitoring data.

b. Data reduction and analysis (DR&A) software for the reduction of the data collected by both the software monitor and the hardware monitoring equipment.

6.0 SYSTEM TESTS

The tests described in the following paragraphs will employ dynamic inputs and flight testing to exercise all functions of the system. It will be necessary to develop test scenarios that will be designed to include general and specific situations which will permit full analysis of system performance. These scenarios will consist of a composite of requirements developed by those individuals most familiar with a specific DABS function. Performance of the system will include all aspects of system functional behavior from the aircraft to the messages formatted to and from the ATC facilities.

The system performance tests will begin with the System Baseline tests, which will establish a baseline of performance at the time of FAA acceptance to identify any major problems within the DABS hardware or software. Following this testing, system modification testing, using modified system software, will be performed. This software will contain improvements based on findings of the System Baseline tests and any additional design features available at that time. Both the System Baseline and the System Modification or regression testing will be completed prior to April 1980 and will be included in the April 1980 TDP. Parameter optimization and further in-depth studies, including the system tests described below, will be conducted subsequent to April 1980.

6.1 SYSTEM BASELINE TESTS

It is the intent that the System Baseline Tests to be performed by NAFEC will augment the Factory and Field Acceptance Tests conducted by the contractor and witnessed by the FAA. The primary purpose of the System Baseline Tests is to establish a baseline of performance for each sensor at the time of system acceptance with those system adaptation parameters recommended and implemented by the contractor. These data will serve as a means of measuring improvements in system performance attained during both subsystem and system testing. The tests will consist of both simulated inputs derived via the ARIES and live flight data obtained from controlled flight tests. It is planned that an ARIES test scenario will be developed that will simulate environmental interference and target information ranging from very good to very poor. That is, target and ATCRBS fruit distributions will be well defined, including mixtures of target types, target levels, and target positions relative to zone and azimuth boundaries. This special or standard scenario will be employed to collect data via the System Data Extractor. The flight tests will be designed to define sensor coverage for radial, orbital, and close-in flights. In addition, range and azimuth accuracy measurements will be accomplished by comparing target positions as reported by the sensor and precision tracking systems. The simulated and live flight test data will consist of: (1) target reply, report, and track data; (2) air-ground data link messages; (3) channel management scheduling; (4) surveillance and communications message handling between the sensor and ATC; (5) performance monitor statistics; and (6) message transfer within sensor functions. The types of analysis to be accomplished in each of these areas are detailed in the following sections where the comprehensive system tests are described.

AD-A072 695 NATIONAL AVIATION FACILITIES EXPERIMENTAL CENTER ATL--ETC F/G 17/7
DISCRETE ADDRESS BEACON SYSTEM (DABS) SINGLE SENSOR PERFORMANCE--ETC(U)
JUL 79 M HOLT

UNCLASSIFIED FAA-NA-79-151 NL

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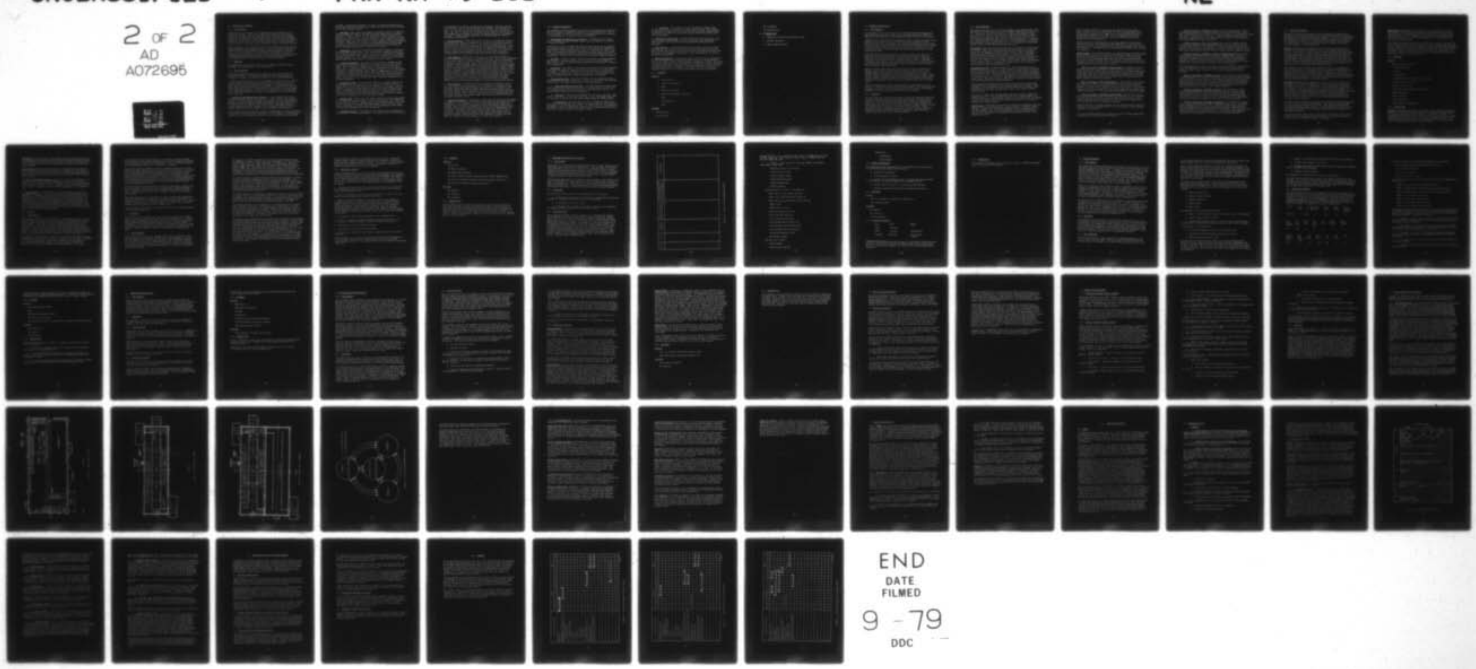

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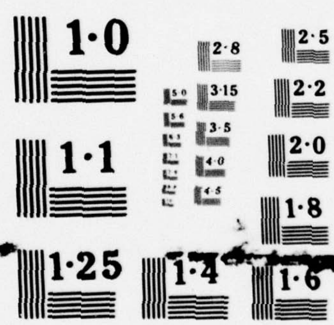


NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

6.2 SURVEILLANCE PROCESSING

6.2.1 TEST OVERVIEW

These tests are to determine the tracking accuracy and capability of the surveillance system. Tests will be conducted utilizing simulated dynamic targets via the ARIES and live controlled project aircraft. The simulated targets will be tested at various signal levels, fruit and DABS environments. The project aircraft will be tested under various fruit and DABS environments. The data collected will be the track and position data in the surveillance file, track data via the DR&A tapes, and position reports to the ATC facility.

ARIES scenarios will be generated to characterize dynamic single and multiple target performance and tracking capability. The live aircraft tests will be conducted with the same parameters as those employed during the simulated tests. Areas of interest in the live tests are the effects of aircraft altitude on system capability, system coverage, reflections, lockout features, collimation and radar beacon correlation. Tracking performance achieved with simulation will be verified during the live aircraft tests.

6.2.2 OBJECTIVE

The single-sensor surveillance tests will be designed to determine sensor performance in providing data to the ATC facility.

6.2.3 DATA COLLECTION

Simulated environments derived via the ARIES and true aircraft within the actual environment at the geographic location of each of the sensors will be employed in support of the tests described in the following paragraphs.

It should be emphasized that the live environment is envisioned to be composed of both targets of opportunity and controlled test aircraft. The level at which the system will be monitored will be limited to the target and track levels unless further investigation is warranted. The number of aircraft and their flight patterns will be established for each specific test as presented in the following paragraphs. All tests, where feasible, will be accomplished with a controlled simulated environment. Performance will be verified using live flight tests.

1. Collimation and Radar/Beacon Correlation - A test aircraft will follow specific flight patterns that will consist of radial, orbital, and straight-line paths. Several ranges, azimuths, and elevations will be investigated for aircraft equipped with DABS and ATCRBS transponders. The data extractor will be employed to record responses from these aircraft to determine range and azimuth collimation errors. The data will be recorded in a manner that will provide pairing of radar and ATCRBS and radar and DABS target responses.

A second phase of this testing will consist of determining correlation performance. Test aircraft equipped with DABS transponders will be employed. The data will be organized to provide information necessary to define radar/beacon (both ATCRBS

and DABS) correlation performance. In order to provide sufficient data to permit proper association, both target report and track data will be recorded via the Data Extraction Module.

2. Detection - These tests are designed to determine detection of DABS-only targets, ATCRBS-only targets, and DABS and ATCRBS targets with collocated radar data. Percent detection is the percentage of target returns that are detected for a known target. Several flight tests will be conducted to determine detectability of a test aircraft for various range, azimuth and altitude positions. These tests will consist of radial, tangential and orbital patterns in order to establish sensor coverage, including minimum and maximum ranges and azimuth blind spots. Close-in overhead flights at various elevations will be conducted to identify the Zenith Cone of Silence.

3. Reflections - The areas of potential reflections relative to each sensor will be derived mathematically. Test aircraft will be employed to confirm that reflections actually are present in those areas identified by the mathematical relationships. These flight tests will be conducted for both ATCRBS and DABS signals. The test results will determine whether or not tracks and target reports have been correctly identified as real or false.

4. Tracking Performance - The reliability and quality of ATCRBS and DABS tracks will be established primarily for synthetic inputs derived from the ARIES. These results will subsequently be verified via live controlled flight tests. In addition, ATCRBS targets of opportunity will be employed. These data are highly dependent on the simulated maneuvers of the test targets. In addition to categorizing the data as DABS or ATCRBS targets, it will be necessary to establish specific types of aircraft flight patterns, maneuvers, signal levels, discrete and non-discrete code structure, and interference rates. The subsets of the tracking performance tests are delineated in the following paragraphs.

a. Straight-Line Track - This situation consists of a single target flying in a straight line for each of two cases. The first consists of radial flights and the second a pattern that is tangential to the sensor. The test target's rf level, velocity, and start range will be varied along with the level of environmental interference as data at the target and track levels will be obtained via the data extraction module. A special subset of the straight line flights will be parallel flight patterns for which the separation of the two targets will be an additional variable.

b. Turning Tracks - These tests will employ simulated aircraft preprogrammed to fly flight patterns consisting of various turning rates. Once again the rf levels will be varied to provide poor to good blip-scan ratios. The tests will be conducted for both DABS and ATCRBS targets within synthetic interference environments. The data extractor will be employed to record target and track data including track status information.

c. Overtaking Patterns - These patterns will consist of two simulated aircraft flying in a leap-frog arrangement. More specifically, one aircraft will

be programmed to fly behind a second aircraft gradually increasing velocity until it passes over the second simulated test aircraft. At this point, the role of the two aircraft will be reversed and the second will overtake the first. The rate of overtake will be varied and the relative levels of the two test targets will be adjusted to provide the required measure of performance. A mixture of ATCRBS and DABS targets will be employed along with various intensities of interference.

d. Crossing Patterns - These patterns will consist of two simulated aircraft intersecting each other at various angles. The path of intersection could be envisioned as the alphabetic letter X. The report and track data prior to, during and after cross will be obtained via the data extraction module. These tests will also involve collection of data for various rf levels which will result in blip-scan ratios ranging from poor to 100 percent. The effect that aircraft speed and environmental interference has on track quality for a crossing pattern will be established for the synthetic test environment.

5. Track Capacity - The intent of this test is to establish the number of DABS and ATCRBS targets that may be processed per scan. This will be accomplished by varying the number of synthetic targets from one that may be considered as a light load to one that has a total of more than 400 targets per scan. The percentage of DABS and ATCRBS targets will be varied as well as the distribution of targets. The distribution will be varied from one that is completely homogeneous in range and azimuth to one that produces peak loading in range and/or azimuth. In addition to the target load, interference will be added at various levels of intensity. The extraction program will be employed to obtain the percentage of the available computer time required to process each test configuration. Scenarios similar to those used in the surveillance functional test (section 5.1) will be used here. In addition, data link and search messages will be included in the scenarios. The distribution of ATCRBS targets will include varying percentages of discrete and non-discrete targets.

6. Track Fidelity - The scenario will be prepared and documented in such a way as to provide the spatial position of each target as a function of time. The target reports and corresponding target tracks will be recorded via the extraction module detailing the spatial position established by the sensor. The range, azimuth, target separations, velocities, target headings and environmental interference will be varied to provide a range of conditions necessary to provide sufficient data defining range, azimuth, and altitude fidelity of both DABS and ATCRBS tracks.

7. Report Dissemination - A dissemination table that will define the destination of reports for overlapping control areas of more than one ATC facility will be established. A test scenario that will contain reports having ranges and altitudes which lie within the boundaries of the dissemination table will be prepared. This scenario will exercise the ability of the dissemination table to determine when reports should be routed to a particular ATC facility or to several. In addition, the scenario will include radar reports, some of which will be associated with ATCRBS or DABS reports while others will be radar-only reports. Target reports that are outputted to the ATC facilities shall be recorded via the data extractor for each test condition.

6.2.4 RESULTS AND ANALYSIS

The information gathered during the Data Collection phase will be analyzed in detail to provide a comprehensive analysis of a single DABS Sensor. Due to the large number of functions that must be addressed during such an analysis, it is considered best to discuss each one individually.

1. Collimation and Radar/Beacon Correlation - Collimation errors between radar and ATCRBS and radar and DABS targets will be presented as a function of range and azimuth.

Correlation of radar and ATCRBS and radar and DABS targets will be presented as the percentage of all radar targets that are correlated with ATCRBS and DABS targets. Further analysis will consist of calculating the ratio of the number of successful correlations obtained with respect to the total number of possible correlations based on track history, and expressing this ratio as a percentage. The data will be presented as a function of range and azimuth.

2. Detection - Curves of percent detection versus type of aircraft maneuvers such as turns, crossing, headings, etc. will be presented for ATCRBS and DABS targets. Sensor coverage including definition of Zenith Cone of Silence will be delineated.

3. Reflections - The number of reflections encountered in each sensor environment, based on targets of opportunity, will be related to the total number of targets. In addition, the duration of reflections will be presented for both controlled flights and targets of opportunity. The percentage of true targets erroneously labeled as reflections will also be obtained.

4. Tracking Performance - Tracking performance will be established based on simulated ATCRBS and DABS targets and on targets of opportunity and controlled test aircraft. The specific areas that will be addressed are:

a. Track Initiation and Track Drop - The times required to initiate and drop tracks will be related to the overall environment and to specific types of aircraft maneuvers and spatial position. Track initiation for two or more proximate aircraft will also be analyzed.

b. Track Life - This will be delineated for each type of aircraft flight pattern. The effect of collocated radar data will be established along with the incidence of Surveillance File Number (SFN) changes for ATCRBS targets.

c. Track Coasts - The percentage of tracks for ATCRBS and DABS that go into coast will be presented as a function of flight patterns. For targets of opportunity it will be one general value. In either case, the distribution of the number of scans for which coast occurred will be presented as well as the duration of coasts in terms of the number of scans.

d. Track Swap - The frequency of track SFN swaps for ATCRBS tracks will be presented as a function of aircraft flight patterns. The incidence of code and/or altitude swap will be determined for proximate ATCRBS targets. Incidences of two SFN's for one aircraft and one SFN for two aircraft will also be determined.

5. Capacity and Response Time - The DABS surveillance data delay time, data loss, and error characteristics for data transmitted from transponders to DABS and DABS to ATC facilities during varying load conditions will be determined.

6. Track Fidelity - An analysis program that performs a curve fit of track positions over seven scans of data will be used to determine the positional error between each reported position and the curve fit position for that scan. The effect of environmental interference, track characteristics and target type will be established.

7. Report Dissemination - Those beacon reports that are actually disseminated to each ATC facility will be compared to those expected to be disseminated based on the known scenario and preestablished dissemination table. The percent of incorrect transactions will be presented. In addition, a similar comparison for radar reports will be performed. The ATCRBS surveillance data will also be analyzed with respect to splits, invalid modes 3/A and C, and new surveillance features such as correlation confidence and code in transition.

6.2.5 RESOURCES

MATERIAL

1. Test Aircraft

2. Targets of Opportunity

3. ARIES

4. NAFEC ATC Facilities

5. Precision Measurement Facilities

EAIR

Phototheodolite

Laser

PERSONNEL

Three Engineers

One Technician

Two Programmers

One System Analyst

6.2.6 PREREQUISITES

1. Completion of functional performance tests

2. Scenarios generated

3. DR&A programs available

6.3 ACCURACY AND RESOLUTION

6.3.1 TEST OVERVIEW

The objectives of this test program are to determine the system accuracy and resolution characteristics of each of the three DABS sensors for ATCRBS and DABS transponder-equipped aircraft operating within the NAFEC test environment.

ACCURACY, which is defined as the capability of DABS to report the actual spatial position of an aircraft target, will be determined by comparison between DABS surveillance data and reference data obtained simultaneously from a NAFEC precision aircraft tracking system. The difference (or error) will be tabulated in both rho/theta and X-Y coordinates and statistically analyzed for specific increments in range, azimuth, altitude, and elevation angles relative to the sensor coordinates.

RESOLUTION is defined as the ability to accurately detect and track two aircraft that are in close proximity. This will be determined by comparing target and track data derived from the DABS sensor to aircraft separation as measured by two precision aircraft tracking systems at NAFEC. Using DABS surveillance data, analysis will include the calculation of aircraft separation values which will then be compared with aircraft separation values obtained from the reference tracking systems.

During all tests, DABS surveillance data will be recorded continuously on magnetic tape at both the sensor and ATC terminals. Extraction of those messages related to the test aircraft will be accomplished by the use of discrete beacon codes assigned to the aircraft during the test period. Reduction and analysis of the data will be accomplished utilizing the NAFEC general purpose computer (Honeywell 66/60) which has been programmed to provide the statistical expression of the accuracy and resolution capability of the DABS sensor.

Results and conclusions will be contained within a final report for each sensor. In addition, an interim report will be issued for the sensor installed at NAFEC for "initial" accuracy and resolution tests that will be conducted immediately after the field acceptance tests for that sensor.

6.3.2 OBJECTIVES

The objectives are to determine the overall accuracy and resolution capability of each of the DABS sensors when operating under dynamic conditions in the ATCRBS and DABS interrogation modes within the required test environment for each sensor. Specific accuracy objectives require range and azimuth data (with appropriate statistics) at various increments of range, azimuth, altitude and elevation angle as related to the sensor site coordinates. Sensor resolution relates to DABS performance as a function of aircraft separation with specific objectives directed towards identifying range resolution, azimuth resolution, and overall system resolution.

6.3.3 DATA COLLECTION

DABS surveillance data will be recorded on magnetic tape simultaneously with recordings of aircraft position data from a NAFEC instrumentation radar facility. These data, which will be obtained utilizing preestablished flight patterns, will be used for determination of DABS accuracy and/or resolution characteristics. Depending upon objectives, the tests will require one or more aircraft equipped with Type A or Type B DABS transponders. In addition, data collection will be accomplished in a test environment that is initially and periodically subjected to certifications for the purpose of maintaining quality control of both DABS and instrumentation data.

Sensor Data: Target-position data (range, azimuth, altitude) for each sensor is contained within each surveillance message transferred to the remote ATC facilities, as described in FAA-RD-74-63A (ATC-33) "Provisional Message Formats for the DABS/NAS Interface," dated 10 October 1974. Recordings of these surveillance messages are available at the surveillance transmit interface via the sensor data extraction equipment, and at the ATC interface at the System Support Facility at NAFEC utilizing the available FR-1800 digital tape recorders. At each of these points, NAFEC time-of-day reference (or equivalent) will also be recorded to permit time of day correlation of sensor data with NAFEC instrumentation data.

Instrumentation Data: The NAFEC Nike-Hercules (N-H) instrumentation radar, which can track two aircraft, will beacon track the test aircraft and provide precise position data every 0.1 seconds with the recorded time of day being synchronized with WWV. Before and after each test, this instrumentation radar will also lock on to a fixed X-band transponder that is located at the CPME for the NAFEC sensor for a period of approximately 5 minutes to obtain quality-control data. These quality-control data and the time that they were obtained shall be included with the tape documentation.

After necessary editing and quality control, the data will be rotated and translated to the coordinates of the sensor(s) under test to permit a direct comparison with data contained within each DABS surveillance message. Each instrumentation tape shall be identified by date, time, and the tracking system utilized.

The EAIR is a single-radar tracking system and will be used to support the Nike-Hercules effort. The phototheodolite and laser tracking systems are intended primarily for minimum-range tracking of test aircraft and as a quality-control check during initial and/or periodic certification of the proposed Nike-Hercules tracking system.

Certification: Certification procedures used during the installation and calibration of each of the Nike-Hercules tracking systems, or whenever special testing is requested for calibration purposes, shall be provided as part of this test program. This will be supplemented by the daily comparison of CPME surveyed coordinates to the measured values obtained with the instrumentation facility.

Since the DABS recording will include message generated for the CPME, a quality control check of the DABS sensor will also be accomplished before, during, and after each test by comparison of recorded surveillance data to the surveyed coordinates of the CPME. These recorded data will permit a quality-control check for the entire tape since a CPME message will be available for every antenna scan.

Although no special instrumentation is necessary within the test aircraft, bench certification of the ATCRBS and DABS transponders is required at the start and end of the test program which may last several weeks. Such certification shall be in accordance with the FAA standards established for each type of transponder.

<u>Flight Program</u>: Aircraft flight patterns are subdivided into two areas: single-aircraft flights for target accuracy and dual-aircraft flights for target resolution. A minimum of six flight plans are proposed for accuracy and three for resolution, although additional data will be collected whenever the aircraft are scheduled for other test programs. Each plan will require a maximum of 4-hours of flight time — with the majority of plans being accomplished during two consecutive 2-hour periods.

<u>Plan #1 - Accuracy - ASR/ARSR* - Minimum Range</u>: To provide for minimum range data that can be correlated with the zenith cone characteristics, a single aircraft will proceed along a radial from zero to 10 miles either side of the DABS sensor at each 1,000-foot increment in altitude up to a maximum altitude of 10,000 feet. Based on aircraft speed, approximately 225 target reports should be available for each altitude, with the entire test of 3.5 hours producing at least 2,250 samples.

<u>Plan #2 - Accuracy - ASR - Medium Range</u>: To obtain medium range data for the terminal environment, a single aircraft will proceed along a specified radial from zero to 60 nautical miles from the sensor at each 1,000-foot increment in altitude up to a maximum altitude of 10,000 feet. Three hundred target reports will be recorded for each radial flight with the entire test requiring a maximum of 4 hours and producing approximately 3,000 data samples.

<u>Plan #3 - Accuracy - ASR/ARSR* - Maximum Range</u>: Aircraft will proceed along a specified radial from the ARSR-2 facility (sensor #2) at an altitude of 26,000 feet until reaching a point 200 miles from the facility. This radial flight which will be repeated four times will produce approximately 1,200 data samples for the 10-second scan period.

Although this plan is intended primarily for the enroute function, data will probably be collected simultaneously at all three sensors to obtain maximum range data for each sensor.

* For the anticipated back-to-back antenna operation, the data sampling will be doubled due to the five-second scan period.

Plan #4 - Accuracy - ASR/ARSR* - Orbital: Aircraft will perform an orbital path around the sensor at a constant range of 10 miles from the sensor. This will be accomplished at each 1,000-foot altitude increment up to a maximum of 10,000 feet, and at a low altitude of 500 feet. Assuming 15 minutes flight time for each orbit, approximately 225 data samples will be available for ASR facilities and 90 data samples for enroute facilities.

Plan #5 - Accuracy - ASR - Low Altitude: Aircraft will perform low-level radial flights from zero to approximately 10 miles from the facility and are applicable specifically to the terminal environment of sensors #1 and #3, where aircraft will be tracked during approaches to airport runways. Based on aircraft speed, approximately 30 data points are expected for each low-level flight.

Plan #6 - Accuracy - ASR/ARSR* - Targets of Opportunity: Whenever circumstances permit, data samples will be collected for DABS, ATCRBS, and radar returns from aircraft that are not specifically assigned to this project but are within the DABS test and evaluation environment, and are being beacon-tracked by a NAFEC instrumentation radar. This will produce extensive overall accuracy data, which will have to be analyzed for applicability.

The following patterns relate to the resolution characteristics of the sensors; i.e., the capability to resolve two aircraft that are in close proximity. During all these flights, aircraft will be altitude separated by at least 500 feet.

Plan #7 - Resolution - ASR/ARSR* - Radial: Two aircraft will proceed along a specified radial from the sensor using VORTAC guidance and ATC radar vectoring. One aircraft will proceed along the radial whereas a second aircraft will criss-cross the path of the first aircraft, each time proceeding to a point approximately 5 miles (or as directed) tangential to the path of the first aircraft. The maximum range of the flights will be approximately 60 miles for the terminal facilities and 100 miles for the enroute facilities.

Plan #8 - Resolution - ASR/ARSR* - Orbital: Two aircraft will proceed along a specified orbital path of the sensor maintaining a constant range from the sensor by the use of VORTAC guidance and the ATC radar vectoring. One aircraft will proceed along the orbit whereas the second aircraft will criss-cross the path of the first aircraft proceeding to a point approximately 5 miles (or as directed) tangential to the path of the first aircraft.

Plan #9 - Resolution - ASR/ARSR* - Tangential: Two aircraft will proceed along a specified 50-mile route that is essentially tangential to the sensor, while performing the criss-cross pattern described above. Radar vectoring will be provided by ATC test personnel and the tangential patterns will be repeated as many times as possible during a 3-hour flight. The purpose of this type of flight is to ascertain which type of resolution (range or azimuth) constitutes the limiting factor from an overall resolution viewpoint.

6.3.4 RESULTS AND ANALYSIS

Processing of the DABS surveillance data and comparison with NAFEC instrumentation data will be accomplished by specially-prepared computer subroutines associated with the NAFEC general purpose computer. A total of nine subroutines are necessary to satisfy the three basic requirements (accuracy, resolution, and certification) pertinent to ascertaining the performance characteristics of the DABS sensor. Each subroutine shall provide a magnetic tape and/or tabulated printout of the processed data.

Accuracy: DABS surveillance messages related to the test aircraft will be extracted from the master recordings by use of the assigned discrete beacon code or, if necessary, by the use of a Track Analysis and Display (TAD) program available on the general purpose computer. Range, azimuth and altitude data in these messages will be compared with NAFEC instrumentation data after the instrumentation data have been rotated and translated to the coordinates of the DABS sensor. The requirement necessitates a comparison each antenna scan period -- with instrumentation data being available every 0.1 seconds. Correlation of data will be accomplished using NAFEC time of day as the reference since this time is periodically synchronized with WWV.

The differences (error) between DABS surveillance data and instrumentation data will be an input to the analysis subroutines that will provide the appropriate statistics for each designated group of comparisons. Data can be grouped in intervals of time, range, azimuth, altitude or elevation angle, as directed by a test director's control card. In addition, the analysis routines shall include the capability of providing histograms and/or pictorial methods of data presentation suitable for report purposes.

Resolution: DABS surveillance messages for each of two test aircraft will be extracted from the master recordings by use of either discrete beacon code assignments or by use of the TAD program. These messages will be analyzed on a scan-by-scan basis as a function of the actual separation between the two test aircraft. The actual separation of aircraft will be calculated from data provided by the Nike-Hercules instrumentation facility at NAFEC. DABS resolution, which is defined as the ability of DABS to accurately track two aircraft that are in close proximity, will be determined individually for range or azimuth orientation or collectively when analyzing data pertinent to overall system resolution.

The resolution test program also includes the calculation of aircraft separation from DABS surveillance data and comparison of the values to those obtained from the reference instrumentation systems. This requirement encompasses both ATCRBS-and DABS-equipped aircraft. Further analysis of data will result in grouping of the data at various ranges and elevation angles relative to the sensor coordinates.

As with the accuracy data, output of the analysis programs will be in a form suitable for report purposes with sufficient data to establish performance characteristics to the desired degree of confidence.

Final Reports: As related to the objectives of this test program, a final report will be submitted for each sensor at the conclusion of the test and evaluation effort. In addition, an interim report will be prepared for the data collected at Sensor #1 (NAFEC) prior to the start of the overall test and evaluation effort; i.e., during or immediately after completion of the DABS field acceptance tests.

Each report will contain statistics for each group of accuracy and resolution data collected during each of the flight test plans previously described. Each group of samples will be further categorized in range, azimuth, altitude and/or elevation angle to obtain high confidence estimates of the differences between the population means of each group (and/or the individual categories). In addition to the above, the report shall contain the applicable histograms and data plots to support the data analyses.

6.3.5 RESOURCES

MATERIAL

Aircraft Tracking Facilities

1 - Phototheodolites

2 - Laser

3 - Nike-Hercules

4 - Extended Area Instrumentation Radar (EAIR)

FR-1800 Digital Tape Recorder

Honeywell 66/60 Computer

Gulfstream and Aerocommander Test Aircraft

ATCRBS Transponder

DABS Transponder

X-Band Transponder

Transceivers for Communications

6.3.6 PREREQUISITES

Resources: Successful completion of the accuracy and resolution test program requires the availability of NAFEC resources as described in this document, including the associated support personnel. In addition, all NAFEC instrumentation facilities used to obtain precise aircraft position data shall have been calibrated and certified for use within the NAFEC test bed. This requirement applies specifically to the Nike-Hercules dual tracking system which is presently being installed for use at NAFEC.

DABS Sensors: Prior the start of any system accuracy and resolution tests, it is assumed that the DABS sensor has been certified as operating within established parameters and that identification (and adjustments related thereto) of those functions that are related to optimization of sensor performance have been completed.

Critical Areas: There are certain aspects of the DABS design that require special consideration in both the collection and analysis of data related to this program. These areas are listed below to indicate that additional time may be necessary in defining system configuration and associated performance characteristics:

1. Elwood - Back-to-Back Antenna - The use of a back-to-back antenna at the ARSR-2 facility results in an ER requirement for a flag in each message identifying which antenna was used in the generation of the range and azimuth values within each message. Thus, the computer subroutine for data reduction can be alerted to this flag to assure complete separation of each antenna's data.

2. Radar Digitizer - The evaluation of the radar digitizer at each sensor requires clarification of the type of digitizer and its relationship to the DABS design. Determining the radar accuracy and resolution characteristics would normally be a required objective of the radar test program and it is assumed that the digitizer will be undergoing its own evaluation apart from the DABS evaluation. It would be appropriate to use the data collected by others during the radar digitizer evaluation since the DABS interface should not cause any deterioration in the tracking accuracy of the digitizer. However, if the schedule permits, radar data will be collected and analyzed using the techniques described in this document.

6.4 DATA LINK

6.4.1 TEST OVERVIEW

The Functional Performance tests (section 5.4) evaluated the integrity of the 112-bit DL message code as well as the ability of the DABS Sensor to correctly process simulated messages for which the transmission parameters were selectively varied. In the System Tests, the DABS DL operation will be fully evaluated in an actual live environment using transponder-equipped aircraft. One index of DL performance is the link reliability, which is the ratio of the number of correctly received messages to the total number of messages transmitted. The System Tests shall ascertain this link reliability for both uplink and downlink channels under normal conditions of channel interference.

Measurement of link reliability requires that each uplink and downlink message be uniquely identified both at the point of origin and at the point of reception. This is done by inserting a unique message identification (ID) number in each message, together with a time code. These message ID numbers are generated by the ground equipment for uplink messages and by an airborne

microprocessor for the downlink messages. In addition, airborne equipment will record the aircraft flight characteristics for each interrogation message and reply message processed by the transponder. This will enable correlation of the airborne data with the data collected on the ground.

Airborne and ground recorders will provide a permanent record of each transmitted and received message both at the sensor and in the aircraft. By noting the aircraft flight characteristics recorded on the airborne data, factors such as desensitization of the transponders due to interrogation by other sensors, uplink multipath problems, and airborne antenna shading during aircraft maneuvers can be noted and controlled. In this way, all external parameters can be eliminated or controlled except the normal interfering signals existing on both uplink and downlink channels. These interfering signals represent the normal operating environment.

Critical resources include a completely operational DABS sensor, together with up to two aircraft, each of which must be equipped with a DABS transponder, a digital recorder, a microprocessor, and instrumentation providing aircraft flight characteristics and time of day. A digital recorder at the sensor is also required.

Among the prerequisites for these tests are that the sensor and airborne data collection systems must be operational. In addition, the DL Functional Performance Tests, the sensor's DABS Reply Processor Subsystem Test (4.1.4), and the Antenna Coverage Tests (4.1.1) must be completed to insure that all variable constants have been adjusted to their optimum values.

Comm A and Comm B interrogations and replies will be used for characterization of the air-ground data link.

6.4.2 OBJECTIVE

The objective of the DL System Test is to evaluate the ability of the DABS sensor to correctly transmit interrogation (uplink) messages and to correctly receive reply (downlink) messages when operated in an actual live environment using transponder-equipped aircraft, under conditions of normal channel interference. This ability shall be numerically ascertained in terms of link reliability, which is defined as the ratio of the number of correctly received messages to the total number of messages transmitted or retransmitted per scan.

6.4.3 DATA COLLECTION

Special Airborne Data Collection Equipment (ADCE) will be installed in the aircraft used for the DL tests. The function of this equipment is to record each interrogation and reply message processed by the transponder, together with the time of day and other information which will enable correlation of the airborne data with data collected on the ground. In addition, information concerning the aircraft's flight characteristics at the time of the message will also be included.

The design of the ADCE is modular in that the basic building blocks may be reconfigured to satisfy various flight test requirements. For the DL tests, the ADCE will consist of a digital recorder, a microprocessor, interface logic, a DABS Transponder, and a Timed Attitude Altitude Heading Reference System (TAAHRS) box. The TAAHRS box will provide time of day along with various flight characteristics such as altitude, heading, and attitude. This information will be stored on tape through the microprocessor and will be periodically recorded to determine when communications between sensor and aircraft may be inhibited due to antenna shading caused by aircraft maneuvering.

For uplink messages, a unique message ID number will be generated by a modification of the Channel Management software in the ground equipment. This message ID number will be decoded at the transponder and stored together with the time code, which has a one-millisecond resolution. For each reply message, another unique message ID number will be generated by the microprocessor, routed to the transponder, and relayed to the ground. In this manner, each interrogation and reply message recorded in the airplane may be correlated with the recorded data at the sensor.

Each uplink message or interrogation transmitted by the sensor will be recorded on magnetic tape from the input message queue of the sensor. The messages will be automatically transferred from the queue to the storage whenever an activity takes place. Each uplink message successfully received at the transponder will be recorded in the aircraft on the digital recorder of the ADCE.

Each downlink message or reply transmitted by the transponder will originate and be recorded in the ADCE. Downlink messages are generated by the transponder with the information in the common message field supplied externally by a microprocessor-controlled equipment. A unique reply message number, and aircraft flight parameters such as heading, pitch, roll, etc. will comprise the downlink information. Recording of successfully received replies will take place at the output queue of the sensor.

The flights will be controlled to avoid areas where differential lobing problems may preclude communications with the aircraft, since these areas will have been previously determined during the Antenna Coverage Test Flights. Instances where communications failures are caused by antenna shading can be determined from the flight characteristics information obtained from the ADCE. With this cause of communications failure eliminated, the remaining causes of the failure are either interference or reduction of transponder sensitivity due to interrogations from another sensor. The second cause can be eliminated, since the time of each interrogation is recorded both in the air and on the ground. By eliminating antenna shading and multiple sensor interrogations, the causes for failure to receive a reply message by the sensor can be reduced to interference only. These signals will represent the normal operating environment at the three sites.

Radial flights are planned at the beginning of the test cycle. During subsequent flights, intentional sharp maneuvers will be executed in areas of space where good antenna coverage is assured. The effects of airborne antenna shading will be determined from the data for the particular aircraft and antenna configuration used during the experiments.

6.4.4 RESULTS AND ANALYSIS

From the combined aircraft attitude and position data obtained from both the ground and airborne recorders, instances where missed messages are attributable to other than channel noise will be identified and eliminated. The remaining data, representing the normal operating environment of channel noise, will then be used to determine the uplink, downlink, and round reliability figures for the DL. Specifically, the following quantities or relationships will be determined:

1. The data delay time, data loss and error characteristics for data link data transmitted between the transponder (aircraft) and the ATC facilities during varying load conditions.

2. Ratio of the number of uplink messages successfully received to the total number of uplink messages sent (uplink reliability).

3. Number of messages transmitted from the ground versus the number of messages requested by the users. To determine where a failure of interrogations occurs, the uplink and downlink communications channels will be monitored separately. Each successful interrogation will be recorded in the target aircraft together with the time of day. From the recorded message numbers, time and aircraft parameters; the number of missed messages will be determined together with possible factors which caused these messages to be missed.

4. Percentage of failed uplink transmissions due to channel noise.

5. Ratio of the number of downlink messages successfully received to the total number of downlink messages transmitted (downlink reliability).

6. Percentage of error-free downlink messages.

7. Percentage of correctable downlink messages.

8. Percentage of failed uplink and downlink communications due to aircraft maneuvers.

Round reliability is the ratio of successfully received downlink messages to the total number of transmitted uplink messages exclusive of extended-length messages (ELM's). It is a figure of merit for the complete interrogation-reply loop.

6.4.5 RESOURCES

Material

Two Aircraft

Two DABS Transponders

Two Digital Tape Recorders

Two Timed Attitude Altitude Heading Reference Systems (TAAHRS) Units

Two Sets of Interfacing Circuitry with Microprocessor Control Unit

Data Collection System Including Tape Recorders

Personnel

Two Engineers

One Technician

One Programmer

6.4.6 PREREQUISITES

Both the sensor and the airborne data collection system must be operational. The Antenna Coverage Tests must be completed in order to determine areas in space where differential lobing might preclude communications. The DABS Reply Processor Subsystem test for the sensor (4.1.4) must also be completed in order to insure that all variable constants have been adjusted to their optimum values. Finally, the Simulated DL Sensor tests of section 5.4 must be completed prior to the System Tests.

6.5 PERFORMANCE MONITOR/FAILURE RECOVERY

6.5.1 TEST OVERVIEW

In section 5.2, the performance monitoring and failure recovery features of the DABS Sensor were tested on a functional level. This functional level testing was accomplished in two phases. In Phase 1, the Hardware Monitor, Software Monitors, and Surveillance Failure/Recovery functions were tested to determine compliance with Engineering Requirement ER-240-26. Phase 2 testing concerned itself with parameter optimization and was accomplished by varying selected parameters using both scenarios and flight tests.

The system testing, which is the subject of this discussion, will concern itself with the observation of sensor operation during the overall period that the DABS is undergoing T&E. There shall not be any parameter changes or variations during the system tests. Status messages shall be recorded and analyzed along with failure indications to ascertain overall performance monitor operation.

6.5.2 OBJECTIVES

The objectives of the system level performance monitor testing are:

1. To determine the adequacy of the monitor in accomplishing the functions necessary to accurately report the status of the DABS sensor.

2. To determine which data to remote.

3. To establish the capability of the DABS to provide full surveillance and communications functions for various system failures.

6.5.3 DATA COLLECTION

Status message information will be collected on a continuous basis during system simulation testing, scheduled flight testing, and whenever the DABS sensor is on the air. A site log (figure 13) shall be maintained indicating when outages occur, the reason for the outage, and the status message content immediately preceding the outage. In addition, if there were indications of the impending outage which did not show in the status message content, this information will be recorded in the site log. Hardware failure data entered in the performance monitor/failure recovery site log will be used for the reliability and maintainability evaluation discussed in section 6.8. Observations of the overall performance monitor/failure recovery operation with specific emphasis on the following parameters shall occur during the total period of time the DABS is undergoing T&E.

DATE	TIME	TYPE OF FAILURE	STATUS MESSAGE PRIOR TO FAILURE	OTHER INDICATIONS NOT REFLECTED IN STATUS MESSAGE	COMMENTS

FIGURE 13. SITE LOG FOR PERFORMANCE MONITOR

Hardware Monitors - main transmitter power output for ATCRBS, DABS low power and DABS high power. Omni transmitter power output for ATCRBS, DABS low power, and DABS high power.

- Receiver - Noise output for each video channel - sum channel video signal - Omni video

- Monopulse outputs for test input

- Real Time clock status

- Azimuth register status

- Power supply variations

- Cabinet Temperatures

- CPME interchange

Software Monitors - A count of the number of:

DABS tracks in coast status (state S1)

DABS tracks in all-call status (state S2)

DABS tracks receiving external data (state S3)

ATCRBS tracks

ATCRBS tracks in coast

Delivered messages this scan

Expired messages this scan

Reply storage overflow flag

Input message queue overflow flag

Output message buffer overflow flag

Active message file overflow flag

Collimation difference table

Beacon strobe report

Adjacent sensor inputs:

Status message

CPME track data message

ATARS inputs

Test Message

Status Message

6.5.4 RESULTS AND ANALYSIS

The following pertinent information shall be available at the completion of the overall system performance monitor testing:

1. Stability of the monitor

2. Which parameters to remote

3. Adequacy of the performance monitor in maintaining system operation if the DABS were operationally employed at an unmanned facility.

4. Failure modes that result in a reduction of DABS functions.

5. Additional parameters which should be measured and reported.

6.5.5 RESOURCES

Material

Site test equipment: oscilloscope, voltmeter, etc.

Test target generator

Personnel

One Engineer

One Technician

One System Analyst

6.5.6 SCHEDULE AND REPORTS

Site	Test	Report
Elwood	overview	
NAFEC	overview	comprehensive
Clementon	**overview	final for all 3 sites

**Overview Testing: Observation and evaluation of performance monitor operation during the full period of time that the DABS is being tested and evaluated. This will not include any changes to or variations of the performance monitor parameters.

6.5.7 PREREQUISITES

The Functional Performance Tests described in section 5.2 should be completed prior to the start of this testing.

6.6 NETWORK MANAGEMENT

6.6.1 TEST OVERVIEW

The definitions of Network Management which are used in this section of the test plan were presented in detail in section 5.5, which is the description of the Network Management Functional Tests. In summary, this section of the test plan primarily addresses the "stand-alone" configuration of Network Management in a multi-sensor environment with overlapping coverage between sites. As was stated in the section on the functional testing of Network Management, there are three phases of testing necessary to fully check out Network Management; namely "software task testing," "functional testing," and "system testing." The first two phases are addressed in the functional tests, therefore, this section will concern itself with Phase 3 or System Testing.

Phase 3 will deal with system testing in order to determine how well Network Management accomplishes its function of insuring adequate surveillance of and communication with aircraft in areas of single coverage as well as common coverage. In this phase, either two or three complete DABS sensors will be operating simultaneously. The targets for one of the sensors will be provided by the ARIES equipment, which simulates real aircraft. Live aircraft will be flown to provide targets to all three sensors simultaneously.

The data from each of the sensors will be displayed on the display and recorded on magnetic tape at the System Test Console (STC). Offline reduction and analysis will be performed on the data which are stored on the magnetic tape. The STC will also be used to simulate an ATC Facility by transmitting priority messages and control state assignments about each aircraft to the appropriate DABS sensor. This function entails writing a software driver program to execute a given scenario by determining when a message is to be transmitted and then formatting the message and transmitting it.

6.6.2 OBJECTIVES

The purpose of these system tests is to determine and characterize the Network Management interrelationships among sensors in terms of providing adequate surveillance of and communications with aircraft which are located in areas of overlapping sensor coverage. As was stated above, the stand-alone configuration of Network Management will be tested and evaluated during these runs. Some baseline data will be collected on the netted Network Management configuration for comparison purposes with the "stand-alone" concept.

6.6.3 DATA COLLECTION

Data will be collected to characterize how well Network Management carries out its overall functions under a variety of input conditions derived from simulated and/or live scenarios. The data extraction software will be used

at each of the DABS sites to record the appropriate portion of the global data base on magnetic tape for further offline reduction and analysis.

Also, the data collection software in the STC will record all messages both sent to and received from each of the sensors for subsequent processing. The specific data to be collected at the sites are the surveillance files for each aircraft, the coverage map, and the priority messages which were received from the STC or the target report messages which were generated. The specific data to be collected at the STC include the time of the priority assignments for each aircraft in the system and the surveillance messages which were received from each of the sensors.

The first area of testing concerns itself with uncontrolled DABS aircraft which enter sensor overlap areas. Uncontrolled DABS aircraft are aircraft which have not been designated as to their control state by the ATC facility. The functions to be checked out for each of the sensors in this area are as follows:

1. Sensor Priority Status
2. Adjacent assigned sensors
3. Altitude Correction
4. ATCRBS Lockout
5. DABS Lockout

The parameters to be inputted and varied are:

1. Number of uncontrolled DABS aircraft (Aircraft Control State Messages)
2. Aircraft range, azimuth, altitude
3. Coverage map parameters varied as a function of cell position which include primary, secondary and transition zones, also DABS lockout management.

The parameters to be outputted are:

1. The Network Management lists in the surveillance files
2. Surveillance and CIDIN messages transmitted to the STC
3. Surveillance messages sent to IPC

The second area of testing concerns itself with controlled DABS aircraft which enter sensor overlap areas and which receive primary assignments from the STC. Controlled DABS aircraft are aircraft which are assigned this state by the ATC facility. The functions to be checked out for each of the sensors in this area are the same as for the first area. The parameters to be inputted and varied are:

1. Number of controlled DABS aircraft (Aircraft Control State Messages)

2. Aircraft range, azimuth, and altitude

3. Coverage map parameters which include primary, secondary and transition zones, also DABS lockout management

4. Messages from STC equipment.

The parameters to be outputted are the same as for area one.

The third area of testing concerns itself with adjacent sensor failure and recovery. The functions to be checked out for each of the sensors in this area are the same as for the first area. The parameters to be inputted and varied are the same as specified in the second area. The parameters to be outputted also are the same as specified in the second area.

6.6.4 RESULTS AND ANALYSIS

The data collected from the Network Management list in the surveillance file will be tabulated by scan for each aircraft and for each of the above-mentioned functions. The table will be the same one which was used in the functional portion of the test plan for Network Management. Along with these data, the surveillance messages at each of the operating sensors will be tabulated to determine the amount and percentages of received target reports for each aircraft on each scan. An example of the table is listed below.

Time	Scan Num.	A/C ID	DABS Target RPT RECV	Reply Type	Track Status	Sensor priority status
12:36:14.1	1	N12345	Y	Roll	S4	P

ADJ Assig. Sensors	COV Map Cell	SPEC Mode	DATA Link Act	Alt Corr	ATCRBS Lockout	DABS Lockout
2/3	205	N	N	2	Y	Y

Sensor Priority Bits	Roll Call Inhib.	A/C Range	A/C Azimuth	A/C ALT	A/C Contr.	IFR
Y/Y	N	30	280	190	Y	N

At the end of each scan the following information will be printed.

No. of priority messages received from STC this scan

No. of aircraft this scan

No. of aircraft reports

Percent of aircraft received.

At the end of the test run, the following information will be summarized for each aircraft.

Number of total scans on each specified aircraft

Number of target reports received from each specified aircraft

Percent of target reports received from each specified aircraft

Summary of all aircraft on all scans

Number of total scans for all aircraft

Number of total target reports received

Percent of total target reports received

The tabulated data will then be compared with the expected results which will be determined independently of the testing. The results from each of the sensors will be analyzed in this way. The data from all the sensors will be grouped and examined to determine the following:

1. The amount of time or scans in which each aircraft was out of contact with the ground, or the amount of time in which lockout prevented position information from being downlinked.

2. The amount of time or scans which each aircraft took to acquire a new site while still in contact with the old site, or the amount of time in which lockout prevented acquisition by a second site.

3. The amount of all-call replies received at all the ground sites caused by unlocking the aircraft for predetermined periods of time due to interference.

4. The amount of time or scans in which each aircraft was primary in more than one sensor.

5. The amount of time or scans in which each aircraft was secondary in all the sensors.

The results from the above analysis will be used to determine the degree to which "stand-alone" Network Management performs its function of insuring adequate surveillance and communication with aircraft in areas of common coverage.

6.6.5 RESOURCES

Material

Three operating DABS sensors

ARIES

DABS Network Management software

Test aircraft plus Avionics

Software driver in STC for "stand-alone" configuration message generation

Personnel

One Mathematician

One Engineer

One Technician

6.6.6 PREREQUISITES

The Prerequisites required to conduct and report the tests before the 1980 TDP are as follows:

1. DABS Network Management stand-alone software must be implemented and checked out by September of 1979.

2. The second ARIES system along with the appropriate hardware and software interfacing between the ARIES must be implemented and checked out by September of 1979.

3. STC software driver program for "stand-alone" configuration message generation must be implemented and checked out by September of 1979.

6.7 COMMUNICATION SYSTEM TESTS

6.7.1 TEST OVERVIEW

During these tests, known scenarios will be provided from the ARIES and Interface Verification Software. Sensor Communication lines will be connected to and monitored by the SSF 9020 and TATF ARTS III. Various combinations of active telephone lines, aircraft traffic loads, and communication message loads will be used. Tests will include operation of the communication links under both normal and error conditions. Specific attention will be given to operation during periods of link switching. Tests with the SSF will include operation of the DABS Front End Processor (FEP).

6.7.2 OBJECTIVES

The objectives of these tests will be to evaluate the overall operation of the DABS Communication System with respect to the suitability of the current design for use with operational DABS sensors.

6.7.3 DATA COLLECTION

During each test, the data transmitted and received on each of the communication links will be recorded at both the sensor and the ATC facilities. Recording at the sensor will be accomplished utilizing the data extractor. Recording at the ATC facilities will be accomplished utilizing the Interface Verification Software.

ARIES scenarios for several different traffic loads will be utilized to control the load on the surveillance links. CIDIN Communication Scenarios with varying mixtures and numbers of communications messages will be used with the Interface Verification Software to control the data load on the CIDIN links.

Simulated modem failures will be introduced during steady-state conditions in order to cause link switch operation.

6.7.4 RESULTS AND ANALYSIS

The data collected will be reduced and the sensor data compared to the SSF and TATF data. Bit error rates and message error rates will be calculated for each link for each load condition.

On the surveillance links, time in storage and unsuccessfully transmitted messages will be analyzed. On the CIDIN communication links, retransmission rates and response time delays will be analyzed. This will include an overall analysis of the adequacy of the CIDIN protocol.

In particular, data occurring during periods preceding and following link switch operation will be studied.

6.7.5 RESOURCES

Material

DABS Sensor

DABS Front End Processor

SSF 9020

TATF ARTS III

Enroute Interface Verification Software

Terminal Interface Verification Software

Data Comparison DR&A Software

Personnel

Three Engineers - Analysts (one per site)

6.7.6 PREREQUISITES

Prior to the start of these tests, the Interface Functional and Communications Functional tests must be completed, and optimum operating modes for the modems determined.

Additionally, the three software packages to be used for data collection and reduction must have been thoroughly tested.

6.8 RELIABILITY AND MAINTAINABILITY

6.8.1 TEST OVERVIEW

The main purpose of the reliability and maintainability evaluation is to uncover weak points or problem areas in the system design. These take the form of distinct or repetitive hardware failure patterns, together with any unusual difficulties encountered in isolating and correcting such failures. The reliability and maintainability evaluation therefore will consist of observing the operational status, failure, and maintenance histories of each of the three sensors. The evaluation will not require the imposition of specific tests or scenarios but will begin at the same time that the other performance tests outlined in this Test Plan start and will run concurrently with all DT&E effort at NAFEC. Data collection will consist of recording any changes in operational status of the equipment and recording a complete history of every hardware failure which occurs in each of the three sensors.

Each sensor is broken down for reliability purposes into over 200 individual reliability elements. A complete and comprehensive running account of the operational status, failure, and maintenance histories of each of these reliability elements will be provided by use of automated techniques. Specifically, each hardware failure history will be identified with the appropriate reliability elements and encoded onto punched cards for data processing. This will result in a continuous failure and maintenance history of over 200 reliability elements per sensor, thereby enhancing the recognition of distinct or repetitive failure patterns.

Using this failure and maintenance history, a secondary objective can be attained, namely, a determination of the Mean Time Between Failure (MTBF) and Mean Down Time (MDT) of the DABS Sensors. These are figures of merit, or numerical indexes, of the overall system reliability and maintainability respectively. They will be obtained through the use of mathematical models, using the element failure and maintenance data as inputs.

6.8.2 OBJECTIVES

The primary objective of the reliability and maintainability evaluation is to ascertain any weak points and problem areas in the system design. These are evidenced by the occurrence of distinct or repetitive failure patterns, as well as unusual difficulties encountered in effecting corrective maintenance.

A secondary objective is to obtain some figures of merit or numerical indexes of the overall system reliability and maintainability of the DABS Sensor, and compare these figures with the corresponding goals specified in the ER. The figure of merit for reliability is the MTBF, which is defined as the average length of time that the system can be expected to operate before the occurrence of a hardware failure which causes a degradation of system performance. The figure of merit for maintainability is the MDT, which is defined as the average length of time that corrective maintenance effort is applied to correct a hardware failure.

6.8.3 DATA COLLECTION

Data collection will consist of logging any event or situation which is different than the normal energized and operational status of the equipment. Such events include: equipment shutdown, preventive maintenance (when equipment shutdown is involved), hardware failures, engineering changes, and changes in system configuration. Data collection will begin for each sensor at the same time that the other performance tests outlined in this Test Plan start. In addition to the three sensors, data will be collected on the Front End Processor (FEP), System Test Console (STC), the modems at the Enroute and Terminal ATC facilities, and the Program Support Equipment (PSE).

Failure and maintenance data as well as changes in status conditions will be entered on a standard log form. Only failures in the actual hardware of the sensor, the STC, the ATC modems and the PSE will be used in the reliability analysis. Failure data recorded in the performance monitor/failure recovery site log discussed in section 6.5.3 will also be used in the reliability and maintainability evaluation.

The operational status of each equipment unit will be shown by one of four symbols. "U," or Uptime, will indicate that the unit is energized and subjected to normal electrical stress. "C" is Corrective maintenance time and indicates all time that a unit is down due to a hardware failure. "E" is used for an Engineering Change while "O" or "other time" includes administrative shutdowns, power outages, etc.

A complete and comprehensive history of every hardware failure will be recorded regardless of whether or not the failure resulted in a degradation of system performance. This failure history shall include the following:

a. Date and time failure began.

b. Symptoms of failure.

c. Corrective maintenance procedures utilized in ascertaining the cause of the failure (e.g. - computer diagnostic routines, observation of waveforms at designated test points, etc.).

d. Isolation of the failure to a Printed Circuit Board (PCB) or other part or component. The name and part number of the affected part shall be entered in the log.

e. Location of the failure, including DABS subsystem.

f. Status of equipment unit during failure interval. This will usually be a combination of "C" and "O" status codes.

"C," or downtime, consists of the actual corrective maintenance time expended. It begins when maintenance personnel actually start troubleshooting the failure and ends when the defective part has been repaired or replaced, any necessary realignment has been performed, and normal operation of the affected part has been restored.

"O," or other time, is considered neutral time (neither uptime nor downtime). This status code will apply from the time that the failure is first noted until the technician begins to troubleshoot the problem. "O" time will also include time expended in waiting for spare parts, waiting for availability of computer time to apply diagnostic routines, and travel time incurred by the maintenance personnel.

g. Offline repair time of replaced PCB's to determine the specific IC chip, transister, or other part of the PCB that failed.

h. Any unusual difficulties encountered in isolating and correcting the failure.

6.8.4 <u>RESULTS AND ANALYSIS</u>

<u>INITIAL ANALYSIS</u> - The reliability and maintainability data collected during the period of observation at each of the three sensor sites will be encoded onto punched cards for analysis by the Automated Reliability Assessment Program (ARAP). This is a set of procedures and computer programs used to reduce and analyse failure and maintenance data.

For reliability purposes, each DABS Sensor is broken down into 20 element types, comprising a total of over 200 elements per sensor. These reliability elements are defined by physical and functional considerations and vary in complexity from a complete equipment such as a Transmitter or Processor, down to a portion of a single PCB. After initial screening, each change in operating status or hardware failure history will be encoded onto punched cards which will be associated with the specific reliability elements to which the events pertain. The reliability elements comprising any given major equipment unit will be obtained from a configuration control list contained within the ARAP.

In addition to the elements comprising the three sensors; the status, failure, and maintenance histories of the elements comprising the FEP, the STC, the extra modems, and the PSE will likewise be encoded for ARAP processing.

<u>INITIAL RESULTS</u> - The outputs of the ARAP processing will be a set of printouts depicting the operational status, failure, and maintenance histories of all the reliability elements comprising the three sections of each of the three DABS Sensors, as well as the FEP, STC, extra modems, and PSE. The operational status summaries will show the sequential time intervals spent by each reliability element in each of the four status conditions, as well as a total summary for each element and for each element type. A history of each hardware failure and parts concerned therewith is also provided in the ARAP printouts. This continuous history of several hundred reliability elements should not only enhance the recognition of distinct or repetitive failure patterns but should also outline any unusual difficulties encountered in repairing these failures.

FINAL ANALYSIS - Inordinate or unreasonable values will be eliminated from the uptimes, downtimes, and number of hardware failures obtained for each element and element type from the initial results. The remaining values will then be applied to a WANG 701C Advanced Programming Calculator. The WANG will calculate element type, section, and system failure rates and mean downtimes (MDT's) for each sensor as well as the system MTBF. The section and system failure rates and MDT's will be computed by means of a mathematical model which will take into account the presence of redundant elements and the manner in which such redundant elements are repaired when failure occurs therein. Depending on location within the sensor, some redundant elements will be repaired immediately upon failure while others will be left in the system until the sensor can be powered down and taken out of service. In accordance with the ER, such shutdowns are permitted only during scheduled maintenance periods which occur every 30 days (720 hours). While schedule maintenance on the three sensors to be evaluated will actually be performed more frequently, the WANG program will have the capability of setting this time between shutdowns to any desired value for the purposes of the mathematical model. Under worst case conditions, this is the 720 hours called for by the ER.

FINAL RESULTS - The results of the WANG analysis will be a printout showing element types, section and system failures rates and MDT's for each sensor. The section values will be for each of the three main sections of the sensor (I&P, Computer, and Communications). In addition, the system MTBF will be included.

Where corresponding element types for the three sensors are found to be statistically compatible, the corresponding uptimes, downtimes, and numbers of failures may be combined and applied to the WANG as inputs. The WANG printout will then represent output values for all three sensors combined.

6.8.5 RESOURCES

Material

Honeywell Computer Time-One-Half Hour per Month

ARAP Computerized Configuration Hardware List

Personnel

One Reliability Engineer

One Assistant

6.8.6 PREREQUISITES

The reliability and maintainability evaluation will not require the imposition of specific tests or scenarios but will begin at the same time that the other Performance Tests outlined in this Test Plan start, and will run concurrently with them. Therefore, there are no special prerequisites for the reliability and maintainability evaluation other than that each sensor being evaluated shall have been accepted by the FAA and in stable operating condition (all initial failures debugged).

7.0 DABS T&E SUPPORT FUNCTIONS

This section addresses the various functions which will support the DABS Test and Evaluation effort. These include statistical analysis (7.1), software support programs (7.2), and system operation and maintenance (7.3). Value Engineering procedures (7.4), which will attempt to identify areas where design simplification and cost reduction can be obtained without sacrificing required functional performance and equipment reliability, are also described.

7.1 STATISTICAL ANALYSIS

In order to make efficient use of NAFEC performance test data and further characterize sensor performance, analysis of various sets of data will be conducted for the three test categories. Although statistical analysis techniques will constitute most of the analysis function, other analysis techniques (e.g., numerical analysis) will be used when appropriate. The goals of the analysis function in DABS performance testing are: (1) to determine sample sizes for various tests, (2) to assure relevancy of test data to test objectives, and (3) to draw conclusions about DABS sensor performance from the test data.

Using statistical techniques, sample sizes will be determined (sizing of tests) prior to conducting a particular test. Should circumstances prevent sizing at that time, sizing will commence after some initial data collection to determine how much more data, if any, should be collected.

Factors such as the expected variability in data observations, the desired precision in the results, and the cost of repeated testing will weigh heavily in the sizing of tests. Accordingly, test sizing in particular and analysis in general will require close coordination between the test engineer and analyst to formulate:

1. Clearly defined test objectives which specify the amount of precision desired in making an inference about the population from which a data sample is being taken. (Precision might be stated in terms of the allowed deviation of a sample mean from the assumed true population mean.)

2. Quantitative statements about the expected variability in observed values, and if known, the expected distribution of the observations.

It is expected that simulated testing based on selected traffic scenarios, and utilizing ATCSF, ARIES and target generator inputs will comprise the bulk of the test data. Consequently, efforts in analysis will be concentrated on gaining as much statistical knowledge as possible from these tests and using them as a basis for comparison with corresponding or closely related live tests.

Whenever assumptions cannot justifiably be made about the distribution of the test data, non-parametric or distribution-free techniques will be employed to the greatest extent possible. These techniques are generally based on the relative values of observation without regard to their distributions. Examples are the runs test, the Kolmogorov-Smirnov tests, and certain rank order statistics, such as Wilcoxon's test.

In most cases, however, normality can be assumed since the distribution of sample means tends toward normality as the sample size increases, regardless of the parent population distribution. If normality can be assumed, there is a wide range of statistical techniques available. Statistical tests of significance, whereby sample test data are used to test the reasonableness of an assumption about the population, will be considered, as well as Analysis of Variance techniques which examine whether several population means are equal (or equivalently, whether several sample means come from the same population). Confidence and/or tolerance intervals within which an unknown population parameter can be said to be located, and related control charts will be constructed when appropriate. Other techniques, such as regression and correlation analysis, will be used if necessary. The final choice of technique will depend upon the test objective.

A further use of the analysis function will be in the optimization of adaptation parameter values. NAFEC performance test results will be used to provide suggested values for the parameters under well-defined conditions.

7.2 SOFTWARE SUPPORT PROGRAMS

7.2.1 FUNCTION OF SOFTWARE SUPPORT PROGRAMS

During the evaluation of the DABS at NAFEC, enormous quantities of data will be collected in the various tests. It is the function of the software support programs to transform these raw data into a product which can be readily interpreted, used, and communicated; and which clearly characterizes the performance of the system. The transformation of these raw data shall be accomplished by means of a wide variety of computer programs.

In order to be a useful tool for the test engineer, these programs must be simple and convenient to use. There must be quick turnaround to aid in investigating causes of faulty performance and to produce results for subsequent tests. Since they will also be used for final test reports, it is essential that the outputs of these programs, both statistical summaries and graphical, be readable, clear and concise.

7.2.2 TYPES OF SOFTWARE SUPPORT PROGRAMS

The ER specifies that the contractor provide two categories of software support programs: one operating on the sensor program support equipment (PSE) to effect a quick-look dump of selectable data types, and the second to operate on an IBM 360 (9020) computer at NAFEC to accomplish extended data processing of the extractor recordings. The scope of the latter shall be such as to "place in evidence all functional behavior of the DABS network." In support of this objective, the FAA has defined and the contractor has agreed to furnish an extensive package of computer programs (Extended Analysis). There are, however, certain requirements for NAFEC T&E which, for one reason or another, fall outside the scope of the ER and which will be developed at NAFEC.

A. The following is a list of software support programs which have been furnished by the contractor for use on the 9020. Most of these programs have been converted to run on the Honeywell.

1. Scenario Generator - Applies scenarios to the sensor via either ARIES or software driver.

2. Tape Lister - Provides a listing of the Data Extraction tape.

3. Tape Synopsis - Reviews and summarizes the contents of data extraction tapes.

4. Tape Filter - Copies a specified subset of data extraction tape.

5. Data Display - Writes logical records of data extraction tape in discriptive terms.

6. Plotter - Draws a Calcomp plot of the input.

7. Track Analysis - Lists tracks found on the data extraction tape.

8. Target Report Analysis - Counts reports by subsets, including specified geometric windows of range and azimuth.

9. Range and Azimuth Accuracy - Computes displacement of individual track points from smoothed average.

10. Reply Analysis - Computes round reliability.

11. IPC Performance Analysis - Does conflict and statistical analysis.

A portion of the above 11 programs is being converted to also run on the PSE.

B. The following is a list of software support programs developed at NAFEC for operation on the Honeywell computer.

1. Accuracy and Resolution, which compares position data from the sensor and ground instrumentation facilities at NAFEC,

2. Data Link Evaluation, which uses both airborne and sensor recordings to characterize link reliability,

3. Tektronix terminal plots of targets in the ARIES input tapes, the sensor surveillance file, and sensor target reports.

4. ARIES - DABS Analysis Program - Compares replies from the ARIES Data Extractor with sensor replies, target reports, surveillance file and disseminated ATC messages.

5. Error Detection Program for messages transmitted from the sensor to ATC facilities.

C. The following is a list of NAFEC-developed programs that run on the PDP-11 located at the DABS site.

1. MDABS - This Program

a. Prints and plots beacon reports and replies.

b. Provides summaries of replies per report and correct confidence bit counts.

c. Provides detection percentages for fixed targets.

d. Summarizes counts of garbled ATCRBS replies.

e. Provides error analyses of target replies and reports.

2. SDABS - This program

a. Plots special symbols for up to three targets.

b. Provides plots of monopulse values plus means and standard deviations.

3. MARIES - This program is the same as the MDABS except it is performed on the ARIES scenarios input tape.

4. Display Program - Displays ATC messages on the ARTS III display.

A good software support system must be dynamic and responsive to the needs of the test engineers. There will doubtless be other requirements that develop during the formalization of NAFEC test plans and procedures and during the tests themselves.

7.2.3 OPERATION

Quick-look programs will operate on a TI 990/10 PSE computer located at the NAFEC site. Budget permitting, it is hoped to include this capacity also at the other two sites.

Since the ER was written, NAFEC has installed a Honeywell 66/60 as its general-purpose computer. It offers quick turnaround and easy access from remote terminals which have been placed at numerous locations at NAFEC. Most extended analysis programs written at NAFEC will be programmed to operate on the Honeywell. Moreover, the contractor-delivered package, which is being written entirely in ANSI FORTRAN, will be converted by NAFEC to run on the Honeywell. These TI programs are designed to produce graphical output, offline, on the CALCOMP plotter. Because of the importance of timely plots in identifying improper functioning of the DABS, NAFEC has purchased a software package, to be installed on the Honeywell, which will permit on-line previewing of all CALCOMP plots on a TEKTRONIX graphics terminal. One such terminal, a 4014, will be located at the NAFEC site (Bldg. 14) and will have an attachment to make hard copies of any displayed plot.

7.3 SYSTEM OPERATION AND MAINTENANCE

Section 7.3.1 describes the test beds where the three DABS sensors are to be evaluated by these performance tests. Primary areas of operation and maintenance responsibility in this test effort are outlined in section 7.3.2.

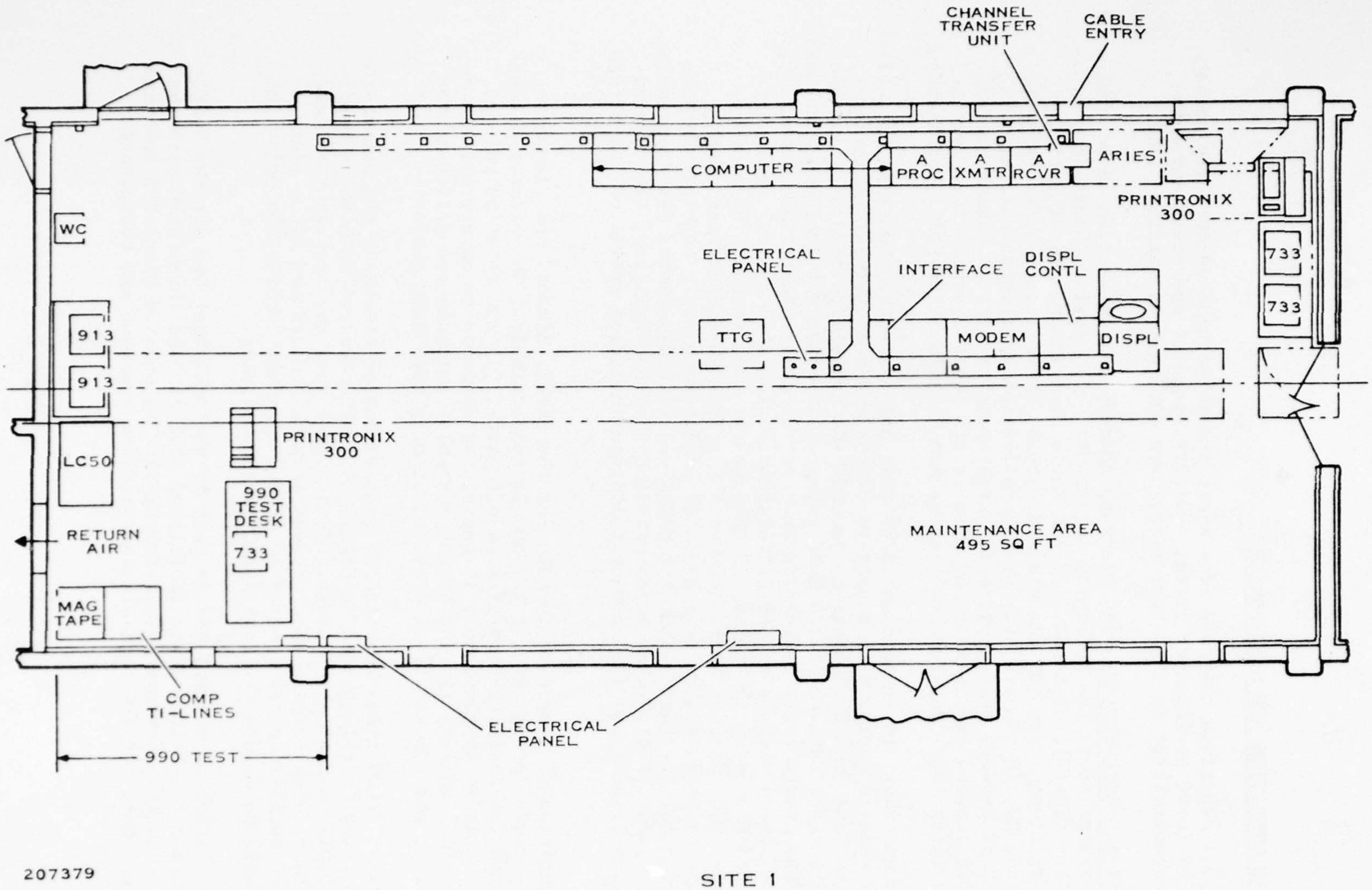
7.3.1 TEST BED DESCRIPTION: The Discrete Address Beacon Systems to be evaluated are to be installed at the following locations: (1) Terminal Radar Beacon Test Facility (TRBTF), at NAFEC; (2) Air Route Surveillance Radar Facility (ARSR-2), at Elwood, and (3) the planned Airport Surveillance Radar (ASR-8), at Clementon, NJ, in the vicinity of the Philadelphia International Airport. All three DABS sensors will provide for high-capacity digital communications capabilities between each sensor and also to the two ATC facilities (System Support Facility (SSF) and Terminal Automation Test Facility (TATF) at NAFEC).

The system necessary to support the DABS test and evaluation consists of: (1) three DABS sensors having both sensor-to-sensor and sensor-to-ATC interfaces; (2) modifications to ATC software to provide the capability of processing DABS and ATCRBS targets derived by the DABS sensors; (3) aircraft equipped with DABS transponders, special data collection and recording equipments, and other electronics; (4) a minimum of one Calibration Performance Monitor Equipment (CPME) for each sensor; (5) a Radar Digitizer for each sensor; (6) a System Test Console (STC) for the NAFEC sensor; (7) a Front End Processor (FEP) for interfacing DABS with Enroute ATC; (8) an Aircraft Reply and Interference Environment Simulator (ARIES) for the NAFEC and Elwood sensors; (9) Programming Support Equipment (PSE), which is an off-line computer facility; (10) Ground Communication System; and (11) sensor buildings including provision for office space.

The configuration of sensor equipments for the NAFEC, Elwood, and Clementon sensors are shown in Figures 14, 15, and 16 respectively. The primary differences between the configuration of each site are: (1) the rotation rate of the ARSR antenna is approximately 10 seconds as compared to an approximate 4-second rate for the ASR; (2) the beacon monopulse antennas are different for each facility; and (3) an STC is provided at only the NAFEC sensor.

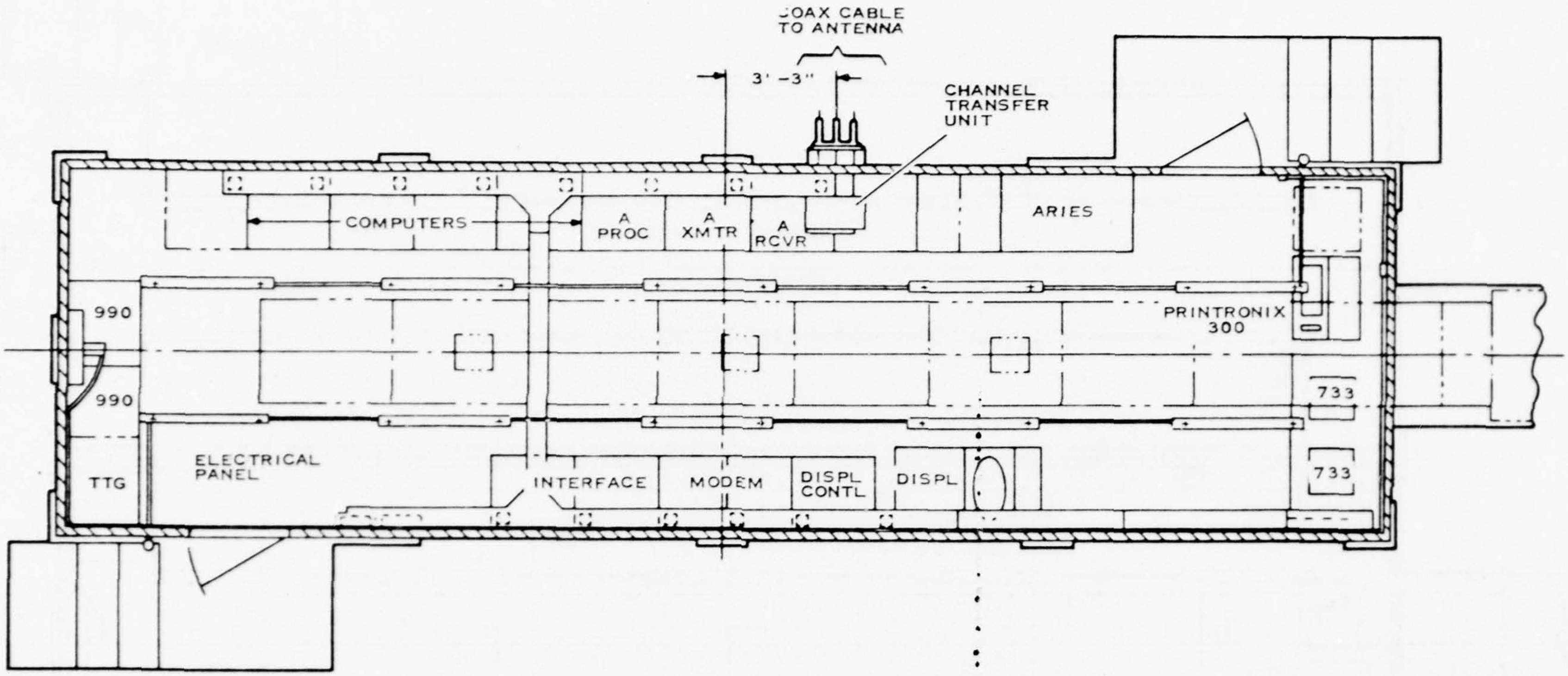
The network of TELCO lines required to provide sensor-to-sensor and sensor-to-ATC message flow is illustrated in Figure 17, which depicts both the surveillance and CIDIN communication links. This figure does not include the lines necessary to provide voice communications between sensors and ATC. Since three of the facilities are located at NAFEC, a common demarcation point for all lines will be within the DABS NAFEC sensor building.

The ATC facilities to be employed as part of the DABS test bed are the NAFEC Enroute SSF and the TATF. These facilities will also be interfaced with the Air Traffic Control Simulation Facility (ATCSF) to provide simulated DABS and ATCRBS target data for ATC software and hardware checkout and acceptance.



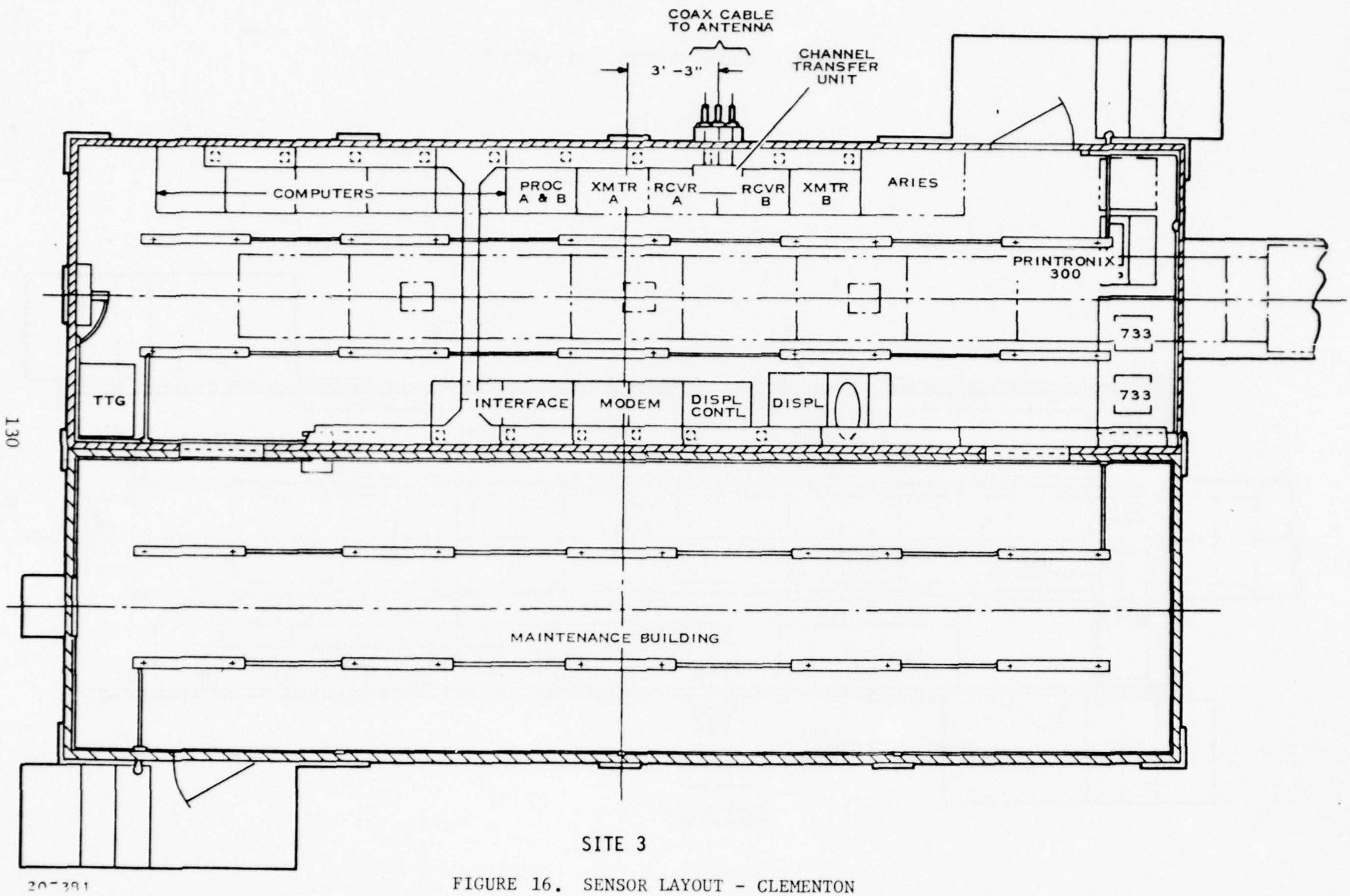
SITE 1

FIGURE 14. SENSOR LAYOUT - NAFEC



SITE 2

FIGURE 15. SENSOR LAYOUT - ELWOOD



SITE 3

FIGURE 16. SENSOR LAYOUT - CLEMENTON

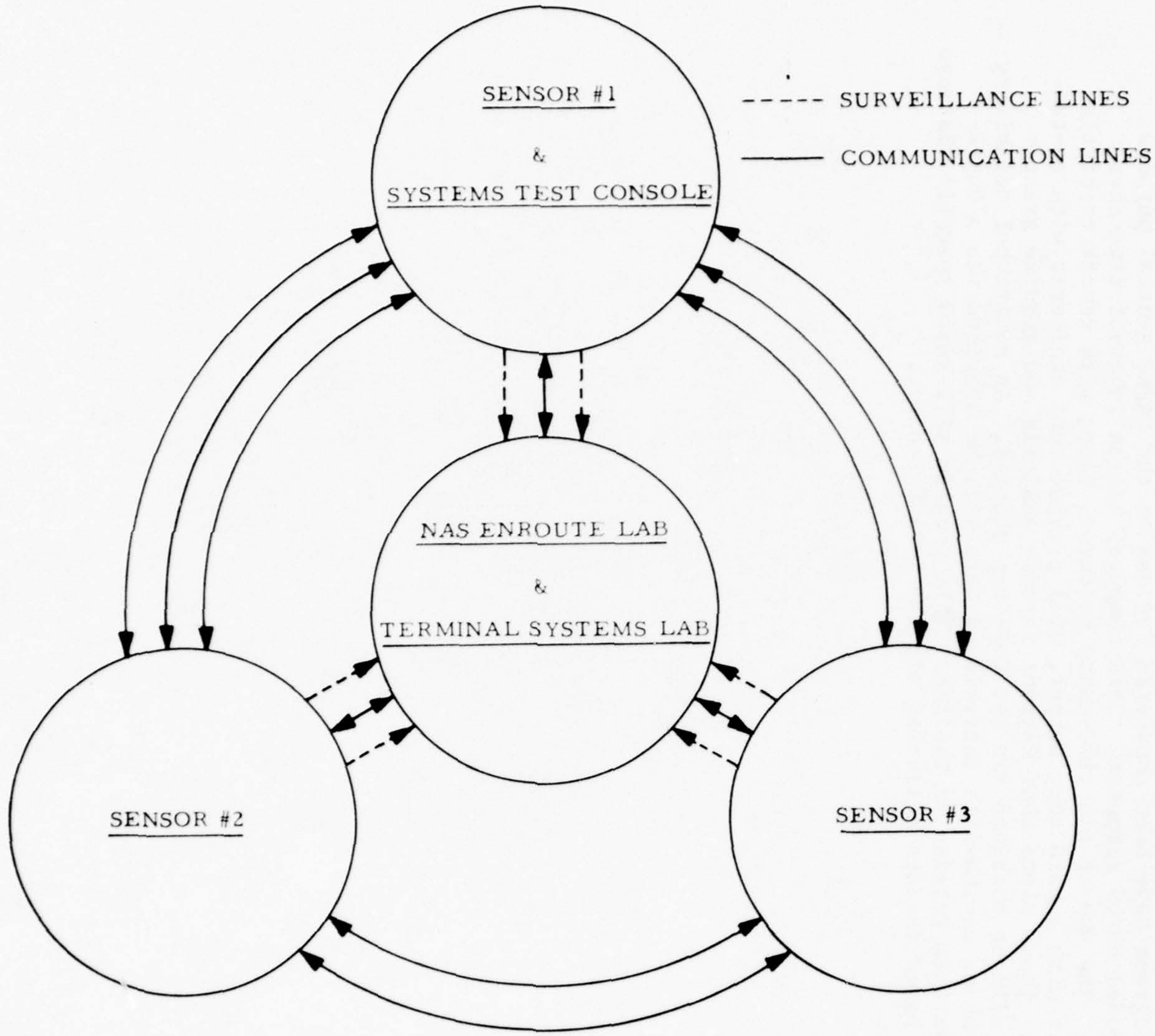


FIGURE 17. TELCO LINE REQUIREMENTS FOR DABS

The DABS Extended Data Analysis Programs, which provide statistics and generate track plot tapes, were originally written for the IBM 360 computer.

The track plots will be derived via a Cal-Comp plotter. The Extended Data Analysis Programs have been converted for use on the NAFEC general purpose Honeywell model 66/60 computer. This computer has an inherent time-share capability. The use of the time-share features, along with remote terminals and displays with a hard copy output, will provide test engineers with on-the-spot plots. Those plots that warrant further analysis and require greater resolution will be obtained via the Cal-Comp plotter. An additional capability of accomplishing on-the-site analysis of data will be provided via a Quick-Look program that resides in the PSE. This program will yield specific listings and counts based on data collected via the Data Extractor.

7.3.2 SITE RESPONSIBILITY: The following primary areas of responsibility are delegated to the DABS sensor support program:

Sensor Start-Up: Responsibility for "start-up" of the DABS sensor shall be a maintenance function. Detailed procedures, as specified by the System Development Contractor (SDC) and the FAA Engineering Requirements, pertinent to clock synchronization, program loading, monopulse calibration and performance monitoring shall be adhered to. These procedures will include, if applicable, modification of site adaptation parameters as designated by users of the facility, and notification of all local ATC facilities of the operational status of the sensor.

Sensor Calibration/Alignment: Responsibility for initial and precalibration of the off-boresight lookup table, using replies from the CPME device, shall be a maintenance function after the procedures have been established for such calibration. Periodic adjustment and/or alignment of individual components and/or parameters within the sensor shall be accomplished in accordance with calibration procedures established during the field acceptance tests. Such calibration may become a major effort during the initial phases of the test and evaluation effort but should become routine as the testing phase approaches completion.

Test-Bed Certification: Certification of the sensor as being ready for testing or operational use during the test and evaluation program is related to the above calibration/alignment function. Data recording and notification procedures shall be established to assure users that the sensor is operating within initial, nominal and/or operating tolerances, as applicable. Such certification will include the generation of coordination messages to ATC facilities, and to other sensors in a multisite environment.

Documentation and Recording: Maintenance responsibility shall include the upkeep of all documentation (at each site) pertinent to the installation, adjustment, inspection and/or repair of individual components and/or subsystems within the sensor. Such documentation shall include appropriate forms necessary for recording specific sensor characteristics including, but not limited to, sensor operation after routine or corrective maintenance.

Preventive Maintenance: Maintenance of a routine nature will be scheduled in advance and will consist primarily of equipment inspection and measurement of specific parameters to assure adherence with preestablished standards. Examples of this type of effort are measurements of sensor power output or receiver sensitivity and correlation of these values with those specified for the sensor performance monitoring function. Normally, this type of maintenance will not require shutdown of the sensor nor prevent scheduling of the sensor for test and evaluation activities.

Corrective Maintenance: Maintenance of a non-routine nature shall be considered corrective maintenance and recording of all such efforts becomes a necessary input to the Test and Evaluation reliability program. Downtime for such corrective action shall be kept at a minimum and the sensor shall be considered as being in this state whenever the sensor is not available for use as scheduled.

Support of Test and Evaluation: When requested, responsibility will include the adjustments of specific operating parameters within the sensor as part of the Test and Evaluation program. Normally this will be related to ascertaining optimum operating standards and/or determining operating characteristics as required for the generation of new sensor specifications. This support, which includes the operation of specialized test equipment or data extraction equipment, could become a major effort during the data collection phase of the program.

Spare Parts: Maintenance responsibility shall include the procurement and upkeep of supplies of spare parts. Normally these spare parts will be of a special nature as identified by the SDC and not normally available at local supply stores. Such spares may include a major component of a sensor subsystem; for example, computer circuit modules.

Depot Repair Service: Repair of certain computer components at the contractor's plant may be necessary. Therefore, sufficient spare components and/or modules should be available to permit a repair and return procedure for such major items. It would be desirable to establish local facilities for repair of complex subsystems, but insufficient information as to the type of service that is necessary precludes such an expenditure at this time. It is assumed that a contract will be available for repair of such items by the SDC on an individual cost basis.

Scheduling of Sensor: The availability of the sensor for Test and Evaluation activities becomes the responsibility of sensor maintenance personnel since schedules must be established to permit routine maintenance, calibration and adjustment prior to allocation of the sensor to one of many possible users. Detailed procedures for scheduling shall be established to permit maximum utilization of each sensor.

Those procedures which depict test configurations and require support from sensor maintenance personnel shall be forwarded to the appropriate facilities at least one week in advance of the proposed test.

Test Equipment: Procurement and upkeep of all sensor test equipment and small tool items shall be the responsibility of each sensor's maintenance program. Calibration and repair of such test equipment shall be performed by the local NAFEC Calibrations Services Branch. Specialized test equipment applicable to specific test programs shall be the responsibility of test and evaluation personnel and should be requested and/or procured well in advance of the scheduled tests.

Diagnostic Programs: Computer programs associated with the TI-990 computer subsystem will be prepared for diagnostic purposes if necessary to supplement those that are to be provided by the SDC. These programs which will be applicable to both hardware and software functions are considered an essential tool in the maintenance of the facility. Therefore, upkeep of these programs and modification of the programs, as necessary for maximum utilization, will be the responsibility of the maintenance program. Included in this area of support are those functions related to the Program Support Equipment (PSE) and the System Test Console (STC).

7.4 DABS VALUE ENGINEERING

7.4.1 GENERAL: Due to the many functional requirements imposed upon the DABS sensor, a very comprehensive set of Engineering Requirements (ER-240-25 and -26) has been prepared. The Engineering Laboratory models of the sensor developed by the contractor to comply with these Engineering Requirements (ER's) accomplish these functions by a complex combination of hardware and software. Sophisticated techniques such as monopulse direction finding, error detection and correction circuitry, and a substantial redundancy of voting computers and data paths are utilized to achieve these functional requirements with the required degree of reliability.

The Test and Evaluation (T&E) effort to be performed by NAFEC upon the three Engineering Laboratory models of the sensor is intended primarily to evaluate the performance of these sensors; including their compliance with the ER's, and in particular whether or not the essential functions required of the sensor for field deployment are met with the required degree of reliability. In addition to determining whether these functional requirements are met, the NAFEC T&E effort will investigate whether these required functions and reliabilities can be achieved by simplifying, modifying and/or eliminating some of the ER's thereby simplifying the sensor and reducing its cost. This comprises Value Engineering (V.E.), which is defined as an effort to obtain the essential operating functions in an equipment with the required degree of reliability and at the lowest cost. In the DABS T&E effort, V.E. will attempt to identify areas of overdesign, overly rigid ER's, and areas where simplification and cost reduction can be effected consistent with the degree of reliability and performance required of the DABS equipment for operational use.

7.4.2 PROCEDURE: V.E. will be applied after the Performance Tests in each functional area have been completed and the resulting data analyzed. At this point, the V.E. effort will attempt to update and modify the ER's pertinent to the functional area concerned based on analysis of the test data. This will be accomplished by an ad hoc committee which will include the T&E personnel cognizant of the functional area concerned as well as other people, for example, Systems Research and Development (SRDS), Lincoln Laboratory, and MITRE personnel. These people will be informed of the meeting times of the committee, the ER's to be subjected to V.E., and the test results. They will be invited to attend the meeting and/or submit recommendations.

The procedure to be followed by the committees in effecting V.E. is as follows:

1. The major functional requirements of the ER will be examined to determine the actual contribution to the system or subsystem performance. In this examination, the degree to which the ER requirement contributes to the overall system performance will be quantitatively estimated.

2. Based on the above analysis, the committee will make judgement upon whether or not the ER requirement is necessary for the required system performance.

3. If deemed necessary, a gross estimate of the cost of the ER requirement will be made. These cost estimates will be relative and will include such considerations as simplification of design, increased reliability, greater ease of equipment maintenance and alignment, and reduction of software and the number of computers. These simplifications should result in lower dollar costs.

4. The ER requirement concerned will be reexamined in light of the above cost estimate.

5. Possible alternate versions of the ER requirement will be investigated. This will include the possibility of relaxing the stringency of requirements or increasing the numerical tolerances (i.e.-sensor recovery in 15 rather than 10 seconds following a functional failure).

6. The relative cost of the alternative versions of the ER requirement will be ascertained, using the same considerations as in (3) above.

Note that the above procedure does not address the actual design of the sensor as interpreted by the Contractor from the ER's. The procedure addresses the ER's themselves and attempts to determine the feasibility of simplifying the ER's and consequent relative costs of the sensor while retaining the required functional ability and reliability. However, where simple design changes indicate potential V.E. simplification, they will be tried.

RESULTS: Upon completion of the evaluation of the ER's pertinent to each functional test area, the corresponding V.E. committee will prepare a list of all ER functional requirements evaluated; indicating those for which reduction, simplification or elimination were determined to be feasible. For each so modified ER requirement, the resulting savings in cost, including design simplification, ease of maintenance and possible dollar costs will be listed.

Upon completion of the T&E effort, the combined ER modifications obtained from all the V.E. committees will be incorporated into the final report on the DABS T&E effort and will be incorporated into the DABS Technical Data Package (TDP) to be delivered to SRDS.

8.0 CONFIGURATION CONTROL

8.1 GENERAL

The DABS System performs many functions, some of which are accomplished by means of hardware and others by software. The software functions are accomplished in a complex architecture of voting computers. Data are transferred between these computers, the global memories, and various input and output points through a system of Tilines and interconnecting coupler pairs, some of which are redundant.

In addition to the complexity of this hardware architecture, the DABS System software is complicated by the large number of tasks separately compiled in its development as well as by the flexibility of task combinations that will reside in any of the DABS computers. Because of these factors, the maintenance of configuration control on a continuous basis for all hardware and software components is vital for accomplishing the performance testing and evaluation of the DABS system.

Configuration control is concerned with knowing the status of the exact current system configuration of each of the three Engineering Laboratory models of the DABS Sensor throughout the test program. By system configuration is meant knowing the exact identification and arrangement of all hardware and software elements of the DABS System throughout the test program. This includes not only the DABS sensors themselves but also DR&A programs and software versions of critical elements in the test bed. Since the DABS Engineering Laboratory models are test beds dedicated to the development, testing, and evaluation of hardware, software, and procedures; both hardware and software changes are to be expected. Such changes, and the detailed procedures for effecting them, likewise come under the purview of configuration control. These procedures will insure that these changes are properly documented in a manner that imposes minimal impact on the overall technical program as well as assuring both the hardware and software integrity of the DABS System.

The system configuration is expressed in the form of various types of documentation for both hardware and software. This documentation will be maintained in one centrally controlled repository by the Configuration Control Engineer (CCE), who will be responsible for assuring that it reflects the latest system configuration, including all changes and revisions. Copies of this documentation will also be maintained by a Documentation Control Specialist (DCS), who may use microfilm, microfiche, or other means to reduce its physical bulk.

Any proposed changes in the system configuration must be studied and approved by a DABS T&E Configuration Control Board (DABS T&E CCB). This board shall consist of the NAFEC DABS Program Manager, the DABS Establishment Manager, the DABS System Engineer (SE), the CCE, and any other individuals whom the DABS Program Manager may select. By thus interfacing with both the DABS T&E CCB and the DCS, the CCE can assure timely and permanent recordings of all configuration updates.

8.2 DOCUMENTATION TYPES

1. HARDWARE

a. Circuit Diagrams, Logic Diagrams, Wiring Lists, Maintenance Manuals, Spare Parts Lists, etc. - This is the standard hardware documentation used by maintenance personnel in effecting normal equipment maintenance. A copy of each item of this hardware documentation reflecting the most recent updatings will be maintained by both the CCE and the DCS.

b. Computerized List of Basic Parts and Components - This list will be derived from the parts list prepared by TI. It will identify items down to an IC chip, transistor, or similar part level.

c. Overall Computerized Configuration Hardware List - This list will identify items down to a printed wiring board (PWB) level. It will include part numbers and will reflect the current hardware configuration of the sensor, including the data path routings of all computers, couplers, Tilines, and associated interface boards and peripherals. A sample item from this list might appear as follows: Coupler, part #323784-1, From: Global Memory A, To: Ensemble #1.

2. SOFTWARE - The configuration control record for software will consist initially of the full documentation supplied by TI in a permanent library in its original form. All work on the software is to be performed using a copy or duplicate of the originals. This software documentation should include:

a. The TI Software Program Design Specification with its narrative description, outline of tasks, flow charts, system descriptions, and users' guide.

b. Program source listings.

c. Keypunched card decks and/or magnetic tapes of source programs and linked object modules.

d. Organization of linked tasks by assigned computer.

e. Operations manuals for loading, starting, adapting, operating, and selecting optional parameters of input and output.

f. Global Memory description and configuration (Data Base Registry).

g. Programmer manuals for operating systems and source language programming.

h. Adaptation parameters, such as coverage maps.

i. Diagnostic and analysis programs.

In addition to the above original software supplied by TI, substantial software will be developed by the NAFEC DABS team in support of the Performance Test effort. Such NAFEC-generated software will include: DABS source tapes, DABS object tapes, test driver tapes, test scenario tapes, analysis programs, data extraction tapes, and various card decks and disks. As much of this material will be common to several users, it should be maintained in the central repository by the CCE to assure updating and to permit ease of location and cross-referencing by the DABS software team.

8.3 CONFIGURATION CHANGES

GENERAL - Configuration changes are of two general types: hardware and software. Hardware configuration changes involve changes in circuitry, including the addition, deletion, or change in value of the parts comprising the circuitry. Software changes involve the changes in logic or coding of program segments, including addition of program patches and deletion of program sections.

There shall be two levels of configuration changes: Test and Permanent. These levels shall apply to both hardware and software configuration changes. The test level of change shall include interim changes, changes in the process of development, and the final version of such changes before official approval is issued. Test changes shall become permanent changes upon official approval by the CCB.

Problem-tracing procedures or other diagnostic routines for hardware or software problem isolation are maintenance tools. As such, they do not come under the purview of configuration control unless analysis of repetitive problems indicates a need for hardware engineering changes or software modifications. Likewise, part replacements; where the circuitry, part types, or part values are not altered; occur as a result of corrective maintenance action and do not come under the scope of configuration control. However, when part values or circuitry are changed, this becomes the responsibility of the CCE, and is discussed in the following paragraph.

LEVEL I - TEST CHANGES - These comprise both hardware and software changes before official approval by the CCB.

1. TEST HARDWARE CHANGES - These involve changes in circuit design, including addition or deletion of circuit elements or changes in their values. It is very important that any proposed change to the hardware be documented prior to actually making the change in order to preserve the integrity of the hardware and also to avoid any possible impact upon other users of the system. Accordingly, the originator of the hardware change shall prepare a DABS Change Proposal (DCP) which will formally document the proposed hardware alteration. A sample of the DCP is shown in figure 18. It shall include the reason for the proposed change, a description of the change, the manner in which it is to be accomplished, suitable diagrams of the logic or circuitry affected by the proposed hardware change, and a test description to check out the proposed change. A list of the required materials plus the estimated cost and man-hours required to effect the proposed change shall also be included in the DCP. The DCP shall be submitted to the DABS SE with copies to the DABS Program Manager, the Establishment Manager, the Site Manager, and the Chairman of the CCB.

DABS CHANGE PROPOSAL

CASE NUMBER ________________ DATE RECEIVED __________

ORIGINATOR

NAME ______________________ ROUTING ______ BLDG ______ PHONE __________

ORGANIZATION ______________________________ DATE ______ PAGE 1 OF ______

PRIORITY ____ URGENT __________ NORMAL __________ TEST ______________

SUBSYSTEM AFFECTED ______ I & P ____ COMPUTER ______ COMM. __________

TYPE OF CHANGE ______ HARDWARE __________ SOFTWARE ______________

END ITEM AFFECTED ____

DESCRIPTIVE TITLE ____

DESCRIPTION OF PROBLEM (CONTINUE ON SUPPLEMENTAL SHEETS) __________

DESCRIPTION OF CHANGE (CONTINUE ON SUPPLEMENTAL SHEETS) __________

REMARKS: (INCLUDE COSTS, DOCUMENTATION, SCHEDULES, AND INTERFACE __________
PROBLEMS-CONTINUE ON SUPPLEMENTAL SHEETS) __________

SE

RECOMMENDATIONS ____

NAFEC AUTHORITY SIGNATURE ______________________ DATE __________

DABS T & E CCB

MEETING DATE __________ RECOMMENDATIONS ______________________

CCB AUTHORITY SIGNATURE ______________________ DATE __________

DABS CHANGE NO. (IF APPROVED) ______________________________

FIGURE 18. DABS CHANGE PROPOSAL FORM

The SE shall evaluate each DCP and may recommend approval, rejection, or further evaluation. The SE shall include his recommendations in the space provided on the form shown in Figure 18. The DCP shall then be referred to the CCB where, upon official approval, the Test Hardware Change shall become a Permanent Hardware Change. This procedure shall apply to all Hardware Changes with the following three exceptions:

a. Interim Changes - Interim changes under the control of an individual engineer should be limited to areas that only impact a specified unit. The SE will normally approve a DCP for an interim change provided the change can be removed when not being evaluated.

b. Urgent Changes - The SE may give verbal approval for urgent hardware changes required to preclude delay of a particular test activity. However, it is still the responsibility of the originator of the change to document it sufficiently to insure the hardware integrity, and then furnish a DCP to the SE with appropriate copies as described above for official CCB approval.

c. Quick Changes - In the case where the originator of the modification must make subsequent quick changes to determine whether his modification performs as intended, he shall obtain verbal approval of the SE, maintain a log or record of these subsequent changes, and then furnish a DCP to the SE with copies as described above for official CCB approval.

For all Test Hardware Changes, a copy of the appropriate Configuration Control documentation shall be updated by the originator of the modification and maintained by the CCE for as long as the Test change is in effect.

2. TEST SOFTWARE CHANGES - These include: (a) interim changes initiated by software programmers for T&E purposes and (b) debugged and agreed-upon modifications for T&E and/or mission enhancement.

a. Interim Changes - These shall be the responsibility of each individual programmer for his assigned software area. He shall maintain documentation on the interim change and any subsequent revisions to this change, advising the SE and CCE that such changes are in process. The changes should be made on a copy of the Mission Software Tape.

b. Debugged Changes - These are interim changes which have been debugged, operative, and agreed upon. These changes shall be the responsibility of the individual programmer. The programmer will provide a written description of the change with all supporting material to the SE and the CCE, who will notify affected members of the NAFEC DABS team and maintain the change documentation under appropriate cataloging and identification as an incremental modification. As in interim changes, the debugged and agreed-upon changes should be kept on a copy of the Mission Software Tape until they have been approved by the CCB.

LEVEL II - PERMANENT CHANGES - These comprise both hardware and software changes after official approval by the CCB. The process for CCB approval is as follows:

1. PERMANENT HARDWARE CHANGES - The Test DCP, with the SE's recommendations, shall be submitted to the CCB for evaluation. Before the CCB meets for consideration of a Test change, a copy of the DCP with appropriate endorsement should be forwarded to the SRDS DABS office. The endorsement in particular should address any impact of the proposed hardware change on functional performance. SRDS should also be informed of the date and time of the DABS T&E CCB meeting sufficiently in advance so as to allow SRDS representation at the CCB meeting if desired. Unless SRDS desires additional information or issues instructions to the contrary, approval of the permanent hardware change by the CCB will be final.

Upon official CCB approval, the appropriate documentation will be updated as follows:

a. Handbooks, Instruction Manuals, etc. - The originator of the change shall update copies of the affected pages of the manuals as required. These shall be submitted to the CCE, who in turn will submit them to the DCS, maintaining a copy for himself. The DCS shall permanently update the manuals, providing a new updated copy to the CCE and updated originals to the DABS maintenance personnel.

b. Drawings, Logic Diagrams, Wiring Diagrams, Parts List, etc. - The originator of the change shall update copies of the drawings as required. These rough updates shall be submitted to Drafting whence the revised drawings shall be returned to Maintenance personnel with copies provided to the CCE and DCS.

When engineering changes apply to more than one site, copies of the appropriate updated documentation shall be provided to the Site Managers.

2. PERMANENT SOFTWARE CHANGES - Periodically the SE, in conjunction with the head of the DABS Software Team, shall assess the debugged and agreed-upon changes and submit them to the DABS T&E CCB for approval evaluation. Before the CCB meets for this evaluation, a copy of these debugged changes with appropriate endorsements should be forwarded to the SRDS DABS office. The endorsements in particular should address any impact of these debugged changes on functional performance. SRDS should also be informed of the date and time of the DABS T&E CCB meeting sufficiently in advance so as to allow SRDS representation at the CCB meeting if desired. Unless SRDS desires additional information or issues instructions to the contrary, approval of the debugged changes by the CCB will be final. Upon such approval, the debugged changes shall become permanent software changes which will be identified as particular revisions.

For permanent software changes, the CCE shall obtain and maintain a full and complete library such as enumerated for originally-delivered documentation. He shall also be responsible for maintaining appropriate backup duplicates of documentation and a historical library containing each superceded revision intact.

9.0 RELATED DABS TEST AND EVALUATION EFFORTS

In addition to the NAFEC Performance Tests described in this document, several other related test and evaluation efforts concerning the DABS sensors will be performed. These include DABS/ATC System Testing, Automatic Traffic Advisory and Resolution Service (ATARS), Data-Link Test Bed Implementation Plan, DABS/ATCRBS Compatibility Testing, and DABS/Mode 4 Compatibility Testing. Test plans for these efforts will be covered under separate documents, however, a brief summary of these related tests efforts is presented here.

9.1 DABS/ATC SYSTEM TESTING

DABS/ATC System Testing is planned using both terminal and enroute facilities. Terminal testing will be done utilizing the ARTS III system at the Terminal Automation Test Facility at NAFEC. Enroute testing will be performed utilizing the 9020 system at the System Support Facility (SSF) at NAFEC.

The initial terminal testing will concentrate on the use of DABS surveillance data (including all surveillance-related communications messages) by the ARTS III system in the TATF. This system is being modified to allow the use of DABS as well as ATCRBS. The modifications are mostly changes to ARTS III software but also include new hardware adapters to allow the system to accept digital surveillance data from DABS and also to provide a full duplex CIDIN interface with DABS.

For the enroute testing, modifications are being made to the computer programs presently deployed in the Air Route Traffic Control Centers (ARTCC's). These modifications are specified to allow the DABS sensor interfaces to be used along with ATCRBS sensor inputs. The interface for DABS includes not only surveillance inputs, but also a full duplex communications interface.

9.2 AUTOMATIC TRAFFIC ADVISORY AND RESOLUTION SERVICE (ATARS)

The Automatic Traffic Advisory and Resolution Service ATARS is a ground-based collision avoidance system primarily intended to aid pilots in avoiding mid-air collisions. It is based upon an earlier system called Intermittent Positive Control (IPC), which is being delivered by TI as part of the DABS Engineering Model (EM) contract. Lincoln Laboratory is redesigning the IPC system into the ATARS system, which will provide more information to the pilot in order to avoid a potentially threatening situation.

9.3 DATA LINK TEST BED IMPLEMENTATION PLAN

The function of the data link test bed is to provide near real time weather-related information to suitably equipped aircraft through the DABS data link. Area weather information such as that contained in the national weather data base will be transmitted to aircraft upon request. Terminal surface conditions will also be transmitted to aircraft upon request and then, if desired, be automatically updated as new information becomes available.

The NAFEC data link test bed is constructed using standard weather sensors in conjunction with NAFEC-designed interfaces. All data are provided in digital form to a Local Processor and Display Subsystem (LPDS) which in turn provides the data to an Applications Processor (AP).

The main functions of the LPDS are to collect and store the most current terminal surface conditions, provide an input for free text messages as may be required by ATC, and transmit all data to the AP.

The AP is the heart of the data link test bed. It interfaces to the DABS sensor, the LPDS and the national weather data base. It maintains surveillance files on all aircraft in the area and data files on all information received from the LPDS. It handles all data link requests from aircraft, acquires the desired data, formats and transmits the data to the DABS sensor which in turn transmits it to the aircraft, and even provides for the automatic update of terminal information as required.

Future applications might include interfacing the AP to the Terminal Information Processing System (TIPS) Terminal Flight Data Processors, to ARTS III and/or to Automated Flight Service Stations.

9.4 DABS/ATCRBS COMPATIBILITY TESTING

This test effort is intended to quantitatively determine the extent, if any, to which the operation of a DABS sytem degrades existing ATCRBS facilities. Specifically, these tests shall (1) investigate the effects of DABS interrogations upon ATCRBS transponders and (2) investigate the effects of DABS asynchronous replies (DABS fruit) upon various types of civilian and joint use (FAA/military) ATCRBS reply processors.

9.5 DABS/MODE 4 COMPATIBILITY TESTING

A joint FAA/DOD program has been established to investigate DABS/Mode 4 electromagnetic compatibility. NAFEC's effort in this program is to conduct ATCRBS IFF Mark XII Systems (AIMS) interrogator/processor laboratory tests and to conduct flight tests.

10.0 SCHEDULE

The tests described in previous sections of this plan demonstrate the complexity of the DABS T&E performance testing. There will be many closely related tests some of which must be conducted concurrently in order to complete the program on schedule. Slippages or changes in plan could adversely affect delivery of reports necessary to develop a Technical Data Package (TDP) for procurement of DABS. To provide for these perplexities, and to meet the overall test objectives, it is necessary that testing, data analysis, and resources be systematically planned for and scheduled.

The main emphasis in the scheduling effort has been to utilize all three sensors to distribute the workload of the Test and Evaluation. Full advantage of the three sensors will not be possible since only two sensors will have an ARIES. However, the impact of this limitation will be reduced by developing and employing, where possible, a software target generator that will be designed to run in one of the spare DABS computers.

The overall schedule of the DABS Performance test effort is shown in figure 1 (section 2.4). The scheduled report date for each of the activities shown is indicated by the symbol R. The detailed testing schedules for the DABS Performance test effort at each of the three sites (NAFEC, Elwood, and Clementon) are shown in figures 19, 20, and 21 respectively.

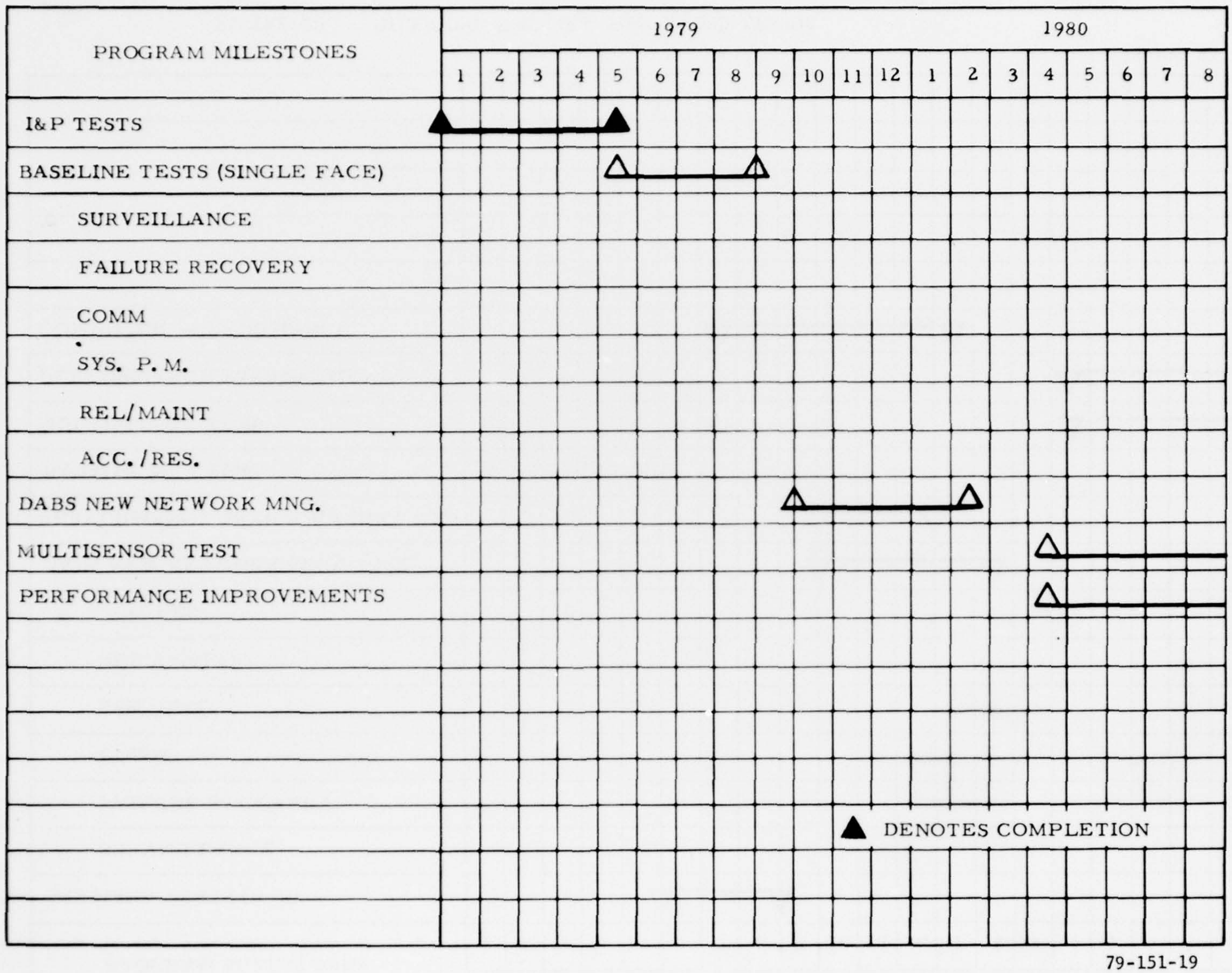


FIGURE 19. MILESTONE SCHEDULE FOR NAFEC SENSOR

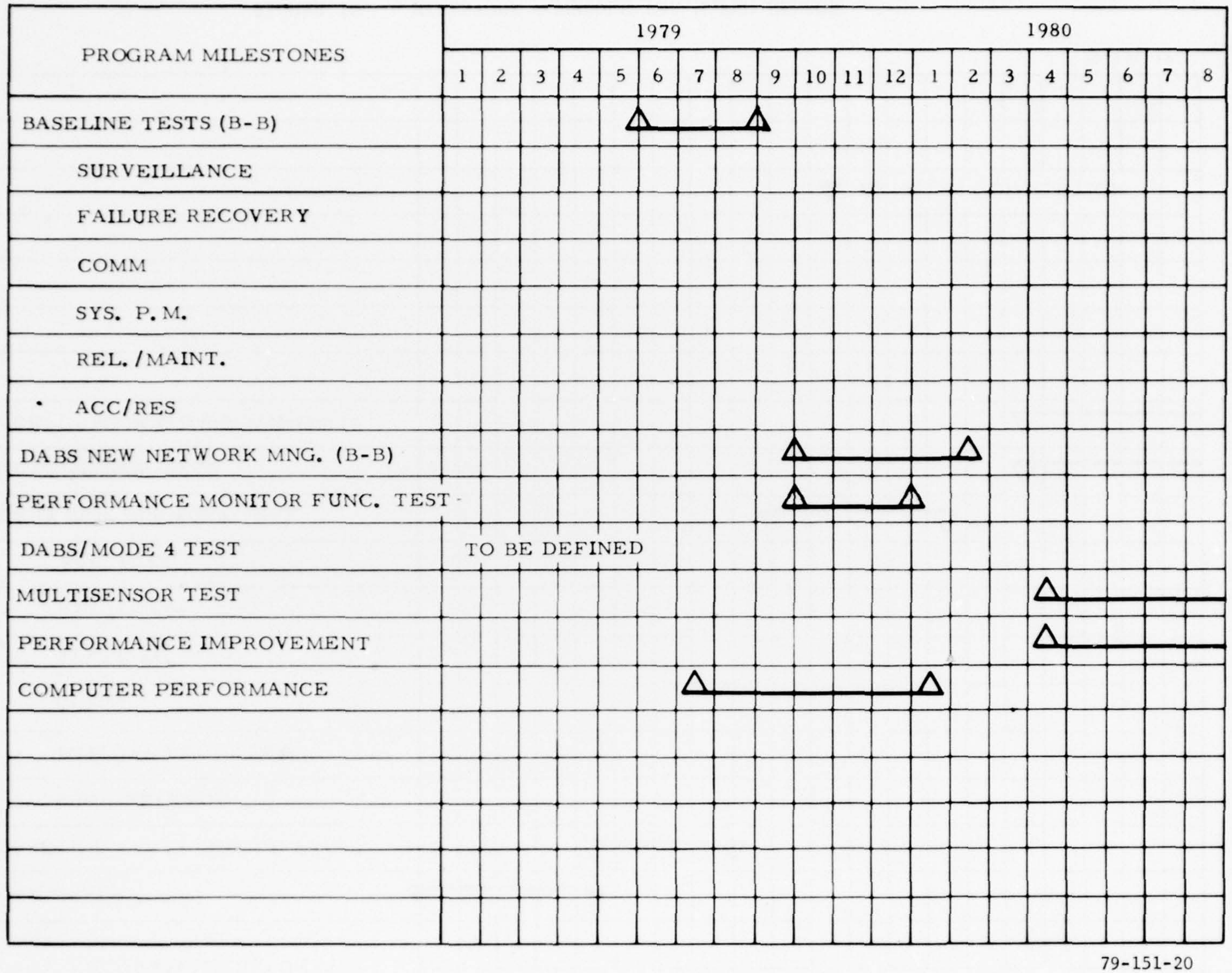


FIGURE 20. MILESTONE SCHEDULE FOR ELWOOD SENSOR

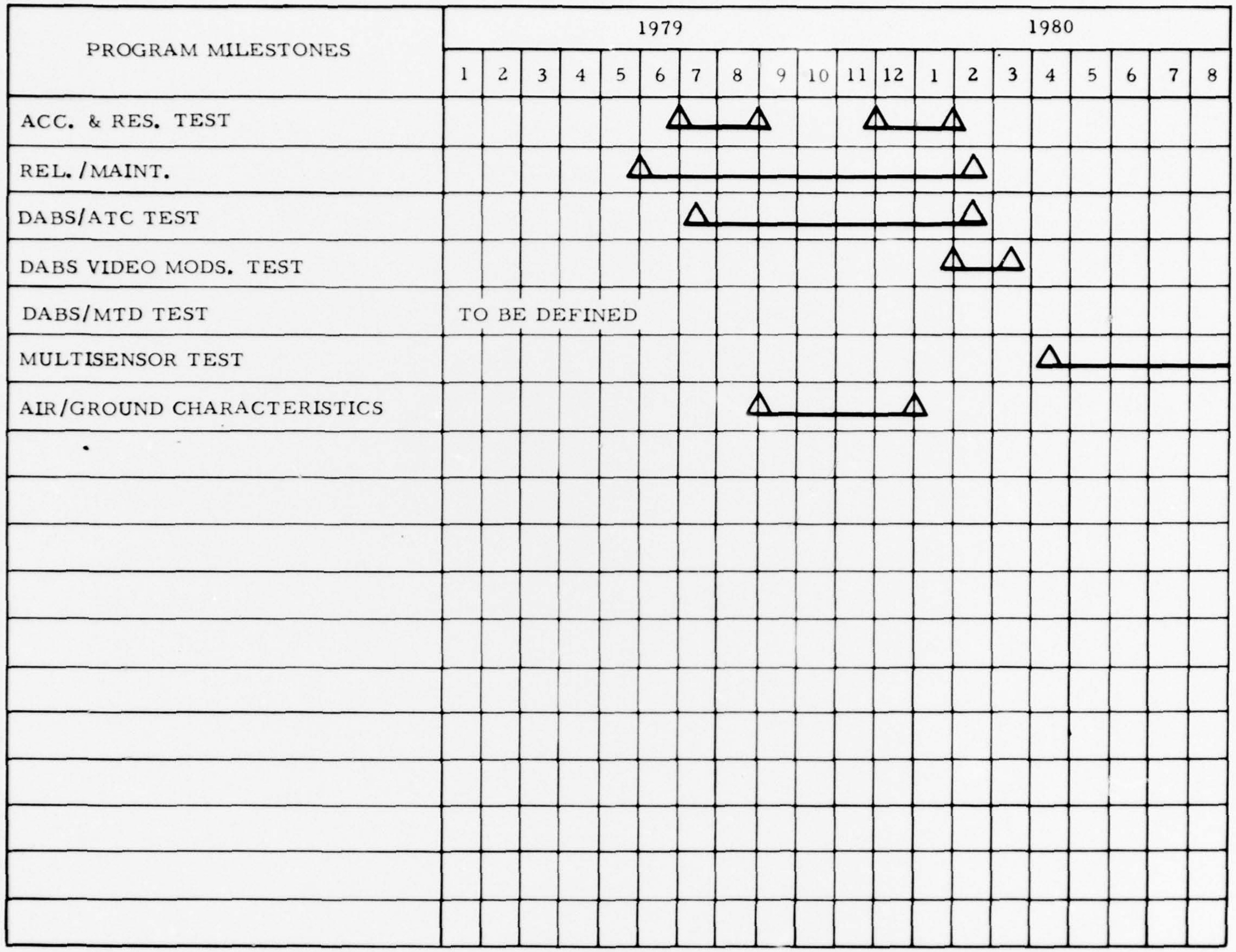


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FIGURE 21. MILESTONE SCHEDULE FOR CLEMENTON SENSOR